

The American Journal of Surgery

PUBLISHED MONTHLY BY THE AMERICAN JOURNAL OF SURGERY, INC.

49 WEST 45TH STREET, NEW YORK, N. Y.

Editor: THURSTON SCOTT WELTON, M.D., NEW YORK

EDITORIAL BOARD

FRED H. ALBEE, N.Y.; CARL BECK, Chicago; CLAUDE S. BECK, Clev.; GEO. R. BRIGHTON, N.Y.; MEREDITH F. CAMPBELL, N.Y.; JAMES T. CASE, Chicago; ISIDORE COHN, N.O.; BRADLEY L. COLEY, N.Y.; FREDERICK A. COLLIER, Ann Arbor; PAUL C. COLONNA, Phila.; ELLIOTT C. CUTLER, Boston; CHARLES A. ELSBERG, N.Y.; HERBERT C. FETT, Brooklyn; JOHN H. GIBBON, Phila.; EMIL GOETSCH, Brooklyn; CHARLES A. GORDON, Brooklyn; DONALD GUTHRIE, Sayre, Pa.; A. E. HERTZLER, Kansas City; LOUIS J. HIRSCHMAN, Detroit; J. M. HITZROT, N.Y.; FREDERICK C. HOLDEN, N.Y.; EMILE F. HOLMAN, San Francisco; JOHN E. JENNINGS, Brooklyn; W. L. KELLER, Washington; T. J. KIRWIN, N.Y.; ARTHUR KRIDA, N.Y.; A. V. S. LAMBERT, N.Y.; MAURICE LENZ, N.Y.; H. H. LYLE, N.Y.; JEROME M. LYNCH, N.Y.; URBAN MAES, N.O.; HARRISON S. MARTLAND, Newark, N.J.; RUDOLPH MATAS, N.O.; ROY D. McCLURE, Detroit; H. C. NAFFZIGER, San Francisco; EMIL NOVAK, Balt.; CLARENCE R. O'CROWLEY, Newark, N.J.; LOUIS E. PHANEUF, Boston; EUGENE H. POOL, N.Y.; JAMES T. PRIESTLEY, Rochester, Minn.; DOUGLAS QUICK, N.Y.; N. P. RATHBUN, Brooklyn; HUBERT A. ROYSTER, Raleigh; HENRY S. RUTH, Phila.; M. G. SEELIG, St. Louis; J. BENTLEY SQUIER, N.Y.; H. J. STANDER, N.Y.; GRANT E. WARD, Baltimore; J. H. WOOLSEY, San Francisco.

NEW SERIES, VOLUME LX

APRIL TO JUNE

1943

THE AMERICAN JOURNAL OF SURGERY, INC., PUBLISHERS
NEW YORK MCMXLIII

COPYRIGHT, 1943
BY THE AMERICAN JOURNAL OF SURGERY, INC.
All Rights Reserved

Printed in the United States of America

CONTENTS OF NEW SERIES, VOLUME LX

ORIGINAL ARTICLES

Foreign Body Localization and Extraction. Description of a Method More Accurate than That Used by the Army	<i>Lewis Gregory Cole</i>	3
Early Laminectomy for Spinal Cord Injury Not Due to Subluxation	{ <i>Foster Kennedy</i> <i>Peter G. Denker</i> <i>Raymond Osborne</i>}	13
Multiple Carcinoma. The Clinical Picture, Diagnosis and Prognosis	<i>Hugo Hellendall</i>	22
Tumors in the Region of the Cauda Equina. A Review of Twenty-five Cases	{ <i>Ira Cohen</i> <i>Lieut. Comdr. Abraham Kaplan</i>}	36
Internal Fixation Device for the Treatment of Intertrochanteric Fractures of the Femur	<i>Herbert H. Thatcher</i>	44
Fallacies of Bone Plating	<i>R. D. Joldersma</i>	50
Study of the Uterine Canal by Direct Obser- vation and Uterogram	<i>W. B. Norment</i>	56
Anesthetic Deaths. A Five-year Report	<i>Frank N. Dealy</i>	63
Supernumerary Breasts. With Special Refer- ence to the Pseudomamma Type	{ <i>Captain Leo R. Weinsbel</i> <i>First Lieut. Nicholas Demakopoulos</i>}	76
Littre's Umbilical Hernia. Case Report	<i>W. Edwin Bird</i>	81
Exploration of the Common Bile Duct. Re- view of 165 Cases	<i>Captain Donald H. Hooker</i>	88
Complications of Thyroid Surgery. Anatomy of the Recurrent Laryngeal Nerve, Middle Thyroid Vein and Inferior Thyroid Artery	<i>Carl A. Bachhuber</i>	96
Complete Reconstruction of Auricle	<i>Morton I. Berson</i>	101
Sulfathiazole Anuria Cured by Decapsulation of the Kidneys. Case Report	{ <i>M. L. Weinstein</i> <i>E. Lawrence Adams</i>}	105
Treatment of Shock and Fresh Wounds	<i>Henry H. Ritter</i>	112
Sacrococcygeal Chordoma. Report of a Case	{ <i>Louis Olsman</i> <i>Maurice Lev</i>}	115
Acute Perforation of a Diverticulum of the Sigmoid. Treatment by Operation and Sulfanilamide	<i>Charles Haines</i>	119
Surgical Treatment of Medical Jaundice. Case Report	{ <i>Dean Macdonald</i> <i>H. Raymond Drysdale</i> <i>John Herrlin, Jr.</i> <i>Walter L. Mersheimer</i>}	122
Multiple Primary Neoplasm of the Colon	<i>Martin Dobelle</i>	126
Brucella Spondylitis. Case Report	<i>Dean H. Echols</i>	130
Cavernous Hemangioma of the Skull. Case Report	{ <i>Captain L. R. J. Kleinsasser</i>}	134
Excision of the Duodenum and Head of the Pancreas for Carcinoma of the Ampulla. Method of Anastomosing Pancreatic Duct to the Jejunum	<i>John Roberts Phillips</i>	137

Pedunculated Ovarian Cysts in Children. An Aid to Diagnosis	{ <i>L. M. Rankin</i> <i>S. A. Eger</i> }	140
Rupture of the Normal Cecum Resulting from Malignant Obstruction of the Splenic Colon	{ <i>Gilbert B. Tepper</i> <i>Theodore B. Massell</i> }	142
Multiple Argentaffinomas in Ileum with Metastases in Lymph Nodes and in the Liver	{ <i>I. Roy Gold</i> <i>David M. Grayzel</i> }	144
Amputation of a Buttock for Eradication of a Cavernous Hemangioma	{ <i>James B. Weaver</i> <i>Mervin J. Rumold</i> }	149
Inexpensive Electric Drill, Saw and Kirschner Wire Drill Guide	{ <i>W. Compere Basom</i> <i>Louis W. Breck</i> }	151
Positive Shoulder Lift for Fractured Clavicles	<i>H. C. Masland</i>	154
Activities of the Naval Hospital at Pearl Harbor Following the Japanese Air Raid of December 7, 1941. Comments on the Care of Battle Casualties	<i>Captain Reynolds Hayden</i>	161
Melanoma. A Review of Thirty-two Cases Admitted to the Brooklyn Cancer Institute during a Five-year Period	{ <i>William E. Howes</i> <i>Milton Birnkrant</i> }	182
Biliary Tract Surgery. Survey in Salt Lake City Hospitals 1930 to 1940 Inclusive	<i>Kenneth B. Castleton</i>	190
Blood Vessel Suture. Its Use Instead of the Ligature in War Surgery.	<i>Charles Goodman</i>	196
Fallacy of Peritoneal Drainage	<i>G. W. Cottis</i>	204
Reconstruction of the Common Duct with a Vitallium Tube. Case Report	<i>Gaston A. Carlucci</i>	209
Recurrent Laryngeal Nerve in Thyroid Surgery. Triangle for Its Recognition and Protection	<i>Max Michael Simon</i>	212
Relationship of Thyrotoxicosis to the Present War Effort. Its Modern Treatment	<i>Abraham O. Wilensky</i>	221
Simplified Aseptic Gastrojejunal Anastomosis Using the Rankin Clamp	<i>H. P. Totten</i>	227
Tuberculous Cervical Adenitis. Treatment by Immobilization	<i>W. Grant Waugh</i>	231
Management of Tumors of the Breast. With Special Emphasis on the Problem of Cancer of the Breast	{ <i>G. L. Robillard</i> <i>S. F. Auerbach</i> <i>A. L. Shapiro</i> }	235
One-stage Radical Resection of the Rectum by Modified Lloyd-Davies Technic.	{ <i>Harold Laufman</i> <i>Ralph Boerne Bettman</i> }	243
Technic of Saphenous Ligation	<i>F. M. Al Akl</i>	248
Relationship of Suture Material to Healing in Thoracoplasty Wounds	{ <i>R. W. Buxton</i> <i>M. L. White, Jr.</i> }	252
Foreskin Isografts	{ <i>Allen E. Sachs</i> <i>Samuel L. Goldberg</i> }	255
Sacrococcygeal Cysts. Report of 200 Cases in an Army Hospital	{ <i>Lieut. Col. Richard B. Weeks</i> <i>Captain George G. Young</i> }	260

Pilonidal Cyst	{ Captain David Brezin First Lieut. Carruthers Love First Lieut Joseph Lawrence }	264
Demerol Hydrochloride. A New Drug in the Practice of Surgery	M. L. Weinstein	267
Lobelin in Asphyxia during Gunshot Surgery	Andrew J. Toman	270
Madelung's Deformity in Sisters	Major David Sloane	272
Myocardial Abscess with Perforation of the Heart Following Staphylococcal Pyemia	James R. Gladden	277
Annular Pancreas. Accompanied by an Aberrant Pancreatic Nodule in the Duodenum	{ Jean L. Chapman H. W. Mossman }	286
Anorectal Pain Due to Follicular Ovarian Cyst	H. Leonard Bolen	289
Volvulus of the Cecum and Ascending Colon. With a Review of the Literature and Presentation of a case	{ Milton Rothman John P. Bruckner Dominick F. Zetena }	292
Septic Abdominal Pregnancy Past Term	{ Samuel Lubin Richard Waltman }	298
Acute Thyroiditis Complicating Scarlet Fever	D. Rees Jensen	301
Undescended Intra-abdominal Testicle with Torsion of the Cord and Embryonic Cell Carcinoma. Case Report	Claude T. Whittington	304
Surgical Operations with the Navy Medical Corps in the South Pacific	Lieut. Comdr. W. M. Johnston	313
Intra-abdominal Injuries	{ Costabile Di Lorenzo Milton Rothman Clarence Howley }	319
Solitary Cyst of the Kidney. Report of Two Cases	Lowrain E. McCrea	328
Theory and Therapy of Shock. Reduced Temperatures in Shock Treatment	Frederick M. Allen	335
New Operation for the repair of the Crucial Ligaments of the Knee	Fred H. Albee	349
Control of Acute Thrombophlebitis with Ultraviolet Blood Irradiation Therapy	George Miley	354
Tobacco Smoking and Cancer of the Lung	Edwin J. Grace	361
Value of Auscultation of the Abdomen in the Diagnosis of Acute Appendicitis	N. C. Stevens	365
Experimental Osteomyelitis	{ Louis Scheman Philip Lewin Sidney Sideman Martha Janota }	371
New Treatment for Acute Dilatation of the Stomach	Edward G. Joseph	381
Dangers of Boric Acid. Its Use as an Irrigant and Report of a Case	{ Charles A. Ross John F. Conway }	386
Continuous Caudal Anesthesia. Preliminary Report of a Newly Modified Technic	{ A. Charles Posner Irwin M. Buch }	396

Caudal Anesthesia in Obstetrics	{ <i>A. C. Mietus</i> <i>R. M. Mitchell</i>}	399
Avertin Anesthesia in Gynecology. Report of a Series of Cases	<i>Lieut. Daniel B. Dorman</i>	403
<i>Bacillus Proteus</i> OX ₁₉ Agglutinated by the Serum of Pregnant Women. Preliminary Report.	<i>I. Gratch</i>	411
Comparison of Tissue Reactions from New Sutures.	<i>Octavus P. Large</i>	415
Instrumental Intestinal Trauma during Lapa- rotomy. Sponge and Tissue Forceps Injuries	<i>Harrison S. Martland</i>	424
Water Blast Injury. Report of Two Unusual Cases	{ <i>Comdr. H. L. Pugh</i> <i>Lieut. R. M. Jensen</i>}	429
Typhoid Osteomyelitis. Case Report	{ <i>Graham A. Kernwein</i> <i>Richard B. Capps</i>}	433
Actinomycosis of the Liver and Lungs	<i>Roland T. Smith</i>	438
Meckel's Diverticulum as a Cause of Intestinal Obstruction. Report of a Case of Volvulus	{ <i>Milton Rothman</i> <i>Dominick F. Zetena</i>}	443
Glioblastoma Multiforme. Report of Three Cases	{ <i>Henry Ward Williams</i> <i>William P. E. Berwald</i>}	447
Successive, Coexistent Tubal Pregnancies. Case Report	{ <i>R. M. Mitchell</i> <i>Lawrence Kurzrok</i>}	450
Rat-bite Fever. Case Report	{ <i>Samuel B. Burk</i> <i>Joseph H. Hodas</i>}	453

The American Journal of Surgery

Copyright, 1943 by The American Journal of Surgery, Inc.

A PRACTICAL JOURNAL BUILT ON MERIT

Fifty-second Year of Continuous Publication

NEW SERIES VOL. LX

APRIL, 1943

NUMBER ONE

Editorials

ABDOMINAL SURGERY

TWENTY years ago an eminent professor of orthopedic surgery was wont to say that it was difficult to interest medical students in bones and joints as their interest was completely absorbed by and lost in the abdomen. Though that statement was true twenty years ago, it is not true today. While many of our better trained recent graduates are going into neurosurgery, orthopedic surgery, thoracic surgery, traumatic surgery, and other surgical specialties, seldom does one limit his work to abdominal surgery.

No longer should abdominal surgery be the step-child of that impossible-to-define parent known as general surgery. It is impossible to define accurately as no one properly trained attempts to practice it. In the eyes of the public a general surgeon is anyone who answers all calls, treats sprains, reduces fractures, attends automobile accidents, sutures wounds, removes appendices and tonsils, delivers babies, attempts to repair hernias, lances boils, and does anything else a liberal legislature and tolerant public will permit.

Something of that attitude is being displayed by hospital staffs, teachers and administrators. Young physicians with insufficient training and supervision are permitted to remove appendices, attempt herniorrhaphies and uterine suspensions, and other intra-abdominal operations although it would be unthinkable for them to

treat a club foot or pass a cystoscope. The idea persists, wholly false though it is, that abdominal surgery is easier to master than some of the other surgical specialties.

The accumulated knowledge of intra-abdominal conditions is now so vast that the time is at hand for young surgeons to go into abdominal surgery as a separate, well-defined specialty. It is difficult to find in this country many abdominal surgeons with the detailed knowledge of the abdomen which neuro-surgeons, thoracic surgeons and other specialists possess of their respective fields.

It is not enough that abdominal surgeons be versed in the gross anatomy and gross pathology of the abdomen, skilled in physical diagnosis and operative technic, and meticulous in pre- and postoperative care. They should know many other things in addition. They should know the indications, limitations and technic of gastroscopy and peritoneoscopy. They should understand what is known about the normal and disturbed physiology of the pancreas, liver, stomach and intestines. They should study blood dyscrasias as related to splenic disturbances. They should be able to consult intelligently with the roentgenologist upon the x-ray diagnosis of gastrointestinal and other intra-abdominal disorders.

Two few roentgenologists are competent in gastrointestinal diagnoses. For his

patient's welfare the abdominal surgeon should know as much as possible about it. He should also study the abnormal embryological development of abdominal structures as revealed in congenital defects requiring surgical treatment. He should be able to prescribe intelligently and in detail both pre- and postoperative diets. He

should understand, as well as present knowledge permits, the manifestations of gastrointestinal allergy.

Should the young surgeon's time and attention be directed as suggested above, he will have little time for anything else. Both he and his patients will profit thereby.

MALCOM THOMPSON, M.D.

POSTOPERATIVE USE OF SULFONAMIDES

IN the repair of cleft lips and in the repair of lacerations of the skin of the face which require minute approximation, it has been found that the local use of sulfonamide powder in the wound forms a very adherent mixture which obliterates completely, or makes exceedingly difficult, the definition of the skin margins. For this reason the local use of such sulfonamide powder has been discontinued and the policy of the oral administration of the appropriate sulfonamide in adequate dosage postoperatively has been adopted. This has resulted

in extremely clean wounds and rapid healing, with an absolute minimum of scarring. It is found that the inflammatory area which usually surrounds a retained skin suture is notably absent.

It is the author's wish, therefore, to recommend this procedure to those who are doing the fine type of repair which requires absolutely precise approximation of skin edges and ability to recognize such skin landmarks as the vermilion border of the lips.

GEORGE C. FOSTER, M.D.



Original Articles

FOREIGN BODY LOCALIZATION AND EXTRACTION

DESCRIPTION OF A METHOD MORE ACCURATE THAN THAT USED BY THE ARMY

LEWIS GREGORY COLE, M.D.

Diplomate of the American Board of Radiology; Roentgenologist to Hudson City Hospital, Hudson,
New York

WHITE PLAINS, NEW YORK

THE detection of a metallic foreign body in the human body is a very simple problem for the roentgenologist; its accurate localization is much more difficult, and the search for and extraction of such a foreign body is often a very perplexing problem for the surgeon. A needle in the palm of a hand as seen in the x-ray film looks simple to remove but, like the Army "buck," it is usually passed from the chief surgeon to his assistant, then to the junior surgeon, and so on down the line, because its removal is without glory if successful, and with a razzing if not. The most notoriously evasive foreign body of recent times is a small fragment of steel in a man's arm that was recently reported and then quoted and requoted from coast to coast. Even though this fragment was only 1 cm. beneath the skin, two prolonged operations failed to remove it. I have seen these scars and stuck my fingers in them. This superficial foreign body was an ideal case for the magnetic method of localization and extraction, but the "diviner or detoner" did not even quiver when used to locate the foreign body deeply embedded in the identical wax model which is the theme of this communication.

The subject of localization was given very little civilian attention in time of peace, but the Army did consider it then and prepared for war by developing an Army x-ray field unit and localizing device.

With unlimited financial backing for experimental work this problem was undertaken with enthusiasm by the roentgenologic staff of the Army and a corps of Army engineers and draftsmen. In due time a field unit was developed and mass production was accomplished. This new field unit is very powerful, and is adaptable for base hospitals or for hospitals where transportation by truck or train is available.

The Army also designed an elaborate localizing device consisting of a sturdy horizontal table which embodies many principles of localizations developed in the last war, notably a convenient method of a very accurately shifting of a shock proof tube to facilitate fluoroscopic search for the foreign body and to determine its depth from a point on the surface. The depth of the foreign body may be read from a scale on the side of the apparatus. It has an ingenious gadget for marking one point on the surface of the body directly above the foreign body with indelible ink.

A phantom is provided with the equipment, so that the depth determining device can be readjusted on the field to assure its accuracy. This phantom has a flat base so that it rests firmly on the fluoroscopic table; its upper surface is also flat and parallel with the base. The marking device is such that a single point on the upper

surface of the phantom or human part is very accurately recorded.

It is planned by the Army to do only

essing films or paper are provided. It is not the intention of the Army to have surgical extractions done in this x-ray tent.



FIG. 1. *Test Object* Wax model containing a foreign body used to determine the accuracy of the Army method of localization compared with another method. The large hole to the left was made in an unsuccessful attempt to remove a foreign body by the Army method. The small hole to the right leads directly to the foreign body, located by another method. The white spot in the center of the small, diamond-shaped hole, is the foreign body. This photograph conveys no sense of depth of the holes, so Figures 2 through 5 are presented to give the depth and width of the two holes.

fluoroscopic examinations for the localization of foreign bodies, therefore, a large black tent having flaps provided with zippers rendering it lightproof and airtight, is part of the equipment.

A written report on special forms to insure uniformity, and an indelible mark on the upper surface of the part, in the manner in which the localizing data are transmitted to the surgeon. Roentgenograms on films or even on paper to show the surgeon the actual size, shape and relative position of the foreign body, are to be specifically avoided. No facilities for proc-

The Army is so proud of this field unit and localizing device that some of them were sent to Russia. It is a beautifully constructed apparatus, but there is just "one fly in this alabaster jar of ointment," namely, *it is not accurate for localizing bullets in the human body.* When this inaccuracy, or at least the inefficiency, of the Army apparatus for localizing foreign bodies in the body rather than in the flat base phantoms was recognized, it was suggested that a localization be done on a human body, preferably a leg, arm or head. However, as no such patient was available,

it was suggested that a wax model, similar in size and shape to the human thigh, be substituted for the Army's flat-based phantom, and that a foreign body embedded in this wax model be localized by the one who had designed the Army apparatus. This cylindrical wax model was so constructed that it has the same tendency to roll outward as does the human leg when the subject is lying on his back. This tendency was discussed and overcome by propping it into position when the localization was done.

In order to avoid any possible error, the localization was repeated on this wax model, and the accuracy of the original localization was confirmed. It was then suggested that the foreign body be extracted through as small a hole as was practical in order to establish the accuracy of this method of localization.

This extraction was undertaken with great enthusiasm by the one who had actually done the localization with the Army apparatus he had designed. A request was made that this procedure be reported to the National Council of Defense, where the subject was to be discussed in the near future. This request was gladly granted but it was considered reciprocal.

The enthusiasm waned as the procedure progressed and the foreign body was not encountered or extracted. A photograph of the wax model (Fig. 1) and a series of roentgenograms tell the rest of the story better than words. In this futile search for the foreign body a hole was made in the wax model large enough to admit three fingers, yet the foreign body was not found by the Army method of localization. The size and shape of this hole are more accurately recorded by the full-sized reproductions of roentgenograms of the wax model made in two directions after the hole had been filled with a barium mixture. (Figs. 2 and 3.) What if there had been a human thigh or head available for this localization, instead of a wax model? If this were the best that could be done by anyone

using any method of localization, it would be unwise to reveal these facts, but this is not the case.

Immediately after this failure to extract the foreign body on the basis of the data determined by the Army method, the same model was employed to illustrate how readily the identical foreign body could be extracted when undertaken on data obtained by another method of localization.

A small diamond-shaped incision was made in the adhesive tape surrounding the wax model, and through this small incision, following the line indicated by a specially constructed apparatus, the one who had failed to extract the foreign body by the Army method and who had never seen this instrument before, used it according to instructions, rapidly evacuated the wax, and hit the foreign body "square on the nose." This was accomplished through a conical hole that was not nearly as large as one's little finger, as shown in Figures 2 and 3. This small conical hole was immediately adjacent to the large hole which had been previously made in the unsuccessful attempt. The small size and shape of this conical hole, indicating the accuracy of this method, is shown even more vividly by full-sized reproductions of roentgenograms (Figs. 4 and 5) than by the photograph of the wax model. (Fig. 1.)

Critics might justly say that the Army method is all right for flat bottomed phantoms and that this method may be all right for wax models, even though they are cylindrical, but what evidence is there that it will work on human beings? The following case, referred by a surgeon who said, "This is a hard nut to crack," is the answer to that question:

A colored woman, weighing nearly 200 pounds, felt a sharp pain in her shoulder as she threw a rug over it. She then threw the rug to the floor, and picked a fragment of needle from her shoulder. A roentgenogram made at the City Hospital revealed two small fragments of a fine needle located high up in the axilla, just below the lower lip of the head of the humerus and about halfway between the

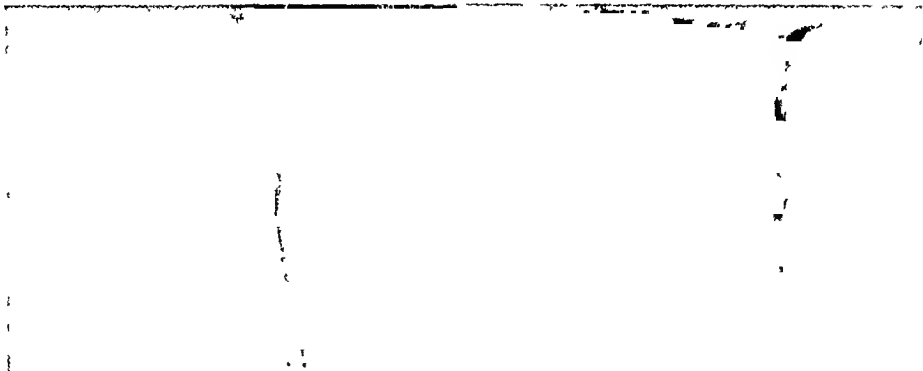


FIG. 2.



FIG. 3.

FIGS. 2 AND 3. *Unsuccessful Approach:* Full sized reproductions of roentgenograms in two directions show the Army hole filled with barium paste. These two roentgenograms accurately indicate the mutilation of the model in the unsuccessful attempt at extraction. Compare with Figures 4 and 5.



FIG. 4.



FIG. 5.

FIGS. 4 AND 5. *Successful Approach:* Full sized reproductions of roentgenograms in two directions show a small conical hole leading directly to the foreign body. This hole indicates the minimal amount of mutilation caused by the successful extraction.

anterior and posterior surfaces of a relatively large shoulder. The localization was accomplished with the aid of instruments which were



FIG. 6. *Sighting Device:* Roentgenogram shows two small fragments of a needle located deep in the human shoulder, one is directly in the center of a sighting device; this one was extracted within forty-seven seconds.

so small as to be carried in one's pocket. They were adapted to an old horizontal fluoroscope and the localization was undertaken under most adverse conditions, with a gallery of doctors waiting to see it fail. Figure 6 shows the two fragments of the needle as they come within the field of the localizing apparatus.

The patient was transferred from the fluoroscopic table to the operating table; the companion surgical instrument was adjusted according to instructions, based on the roentgenologic localization data, and the specific fragment which is in the center of the localizing device (Fig. 6) was removed in forty-seven seconds. The other fragment, slightly off to the side of the field, was not specifically localized and it required nearly twenty minutes to find it, even though the surgeon was searching within its immediate vicinity.

Even this might be considered "happenstance" if it were not for the fact that this method of localization employed a basic

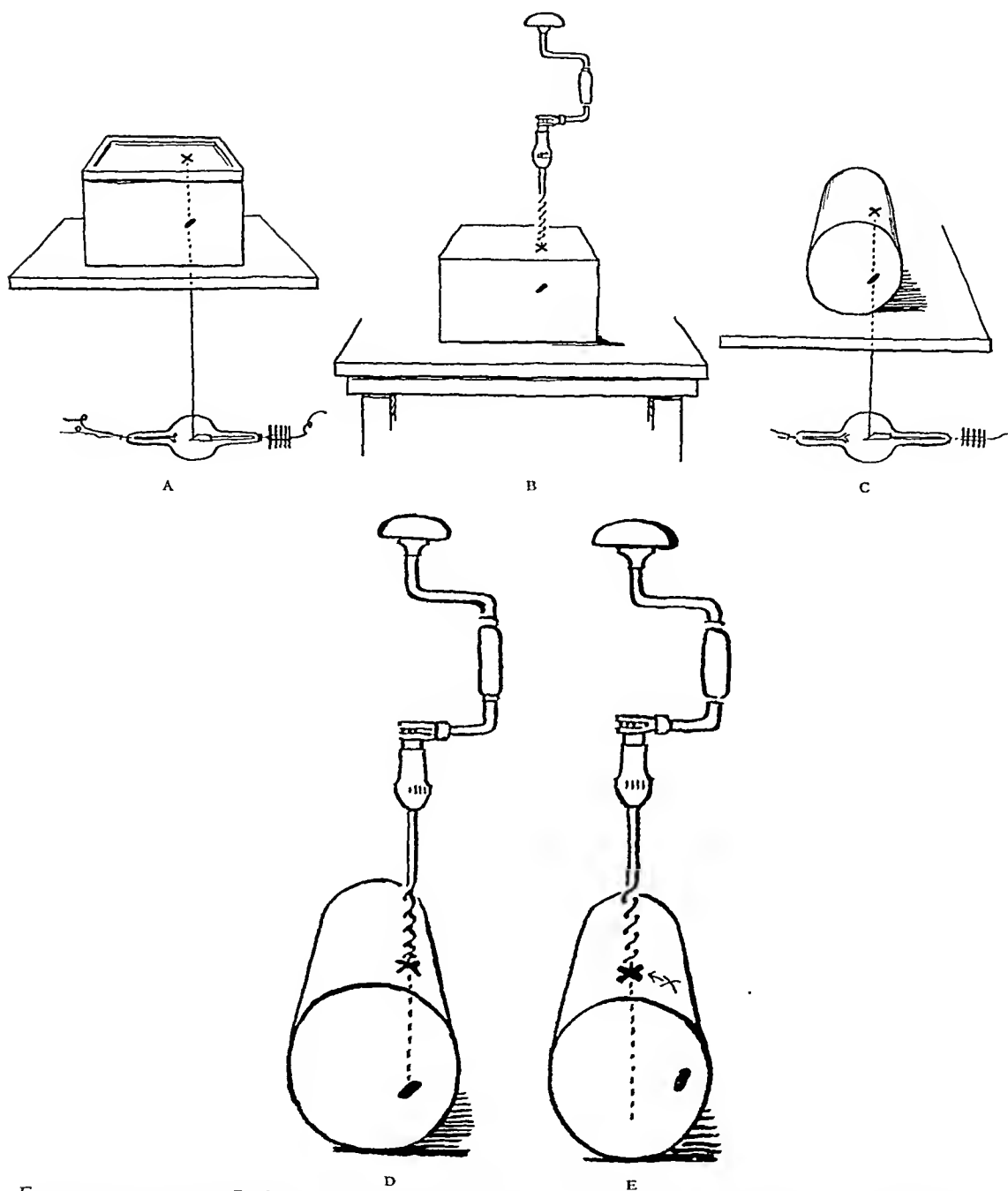
principle that was not employed in the Army method. The principles underlying these two methods might be termed the "one-point method" as employed by the Army, in contradistinction to the "two-point method" by which the foreign body in the cylindrical wax model and the needle in the human shoulder were accurately located. The basic principles employed in these two methods can be more readily conveyed to the reader by drawings than by wordy descriptions. The basic principles of the one point method is shown in Figures 7A, B, C, D and E.

A wooden block contains a foreign body that is deeply situated in it, but it is nearer one end than the other. By fluoroscopic examination, with the tube underneath the square block and the fluoroscopic screen above it, a point on the upper surface, directly above the foreign body, can be accurately determined and marked with an "X" by the Army method. (Fig. 7A.)

If the same block were set on a firm table, a good carpenter could bore a vertical hole directly at the point indicated by the cross (X) and hit the foreign body nine times out of ten; the only time he would miss would be if he tilted his bit one way or the other. (Fig. 7B.)

A foreign body eccentrically embedded in a cylindrical block, like the limb of a tree, likewise could be detected by fluoroscopic examination and its location indicated by an "X" on the upper surface of the block, the same as it was on the square block. This could be done with the Army method. (Fig. 7C.)

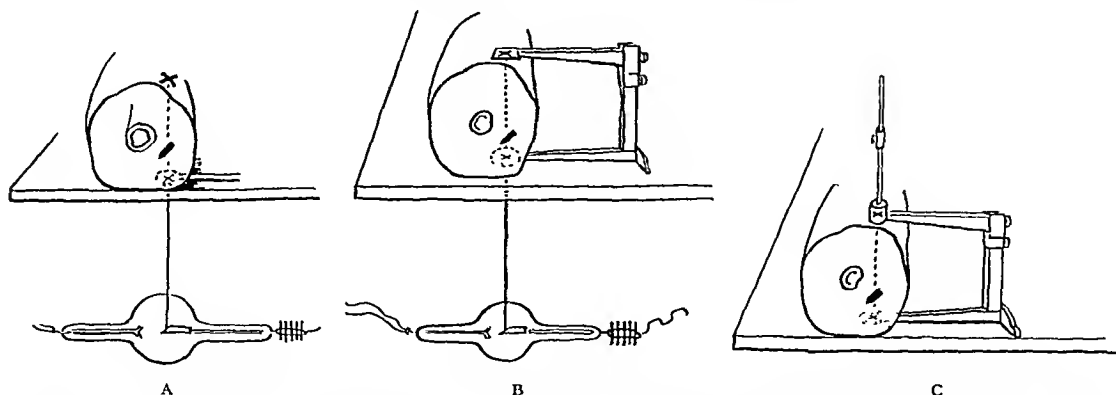
If this localization were done by a roentgenologic architect with the statement that the foreign body was $3\frac{3}{4}$ inches directly beneath a single mark, "X," on the surface, and the wooden cylinder then sent to a carpenter with specifications to bore a hole $3\frac{3}{4}$ inches deep directly beneath this "X" with no specific instructions as to positioning the block when he bored the hole, the carpenter would not place the block "off center" as shown in Figure 7D, in the same position as it was when the localization was



FIGS. 7A, B, C, D AND E. *Basic Principles of the One-point Method:* Drawings which illustrate the fallacy of the one-point method of localization used by the Army. "X" on the upper surface of the block. B, if the square block sat firmly on the table a carpenter could bore a hole straight down and hit the foreign body nine times out of ten. C, a foreign body embedded off center in one end of a cylindrical block could likewise be located by x-ray and its position indicated by an "X" on the upper surface of the block. D, a carpenter instructed to bore directly down would find it difficult to do so because the block would roll, and so unless instructed otherwise would roll it on center, as shown in E. E, thus with the "X" on center, if he bored directly down, he would miss the foreign body by a finger's breadth; thus the fallacy of the one-point method.

done, first because he would not know what that position was, and secondly because with the "X" off center, it would tend to

any combination of the four. In these instances the problem becomes immensely more complicated.



FIGS. 8A, B AND C. *Basic Principles of Two-point Method:* Drawings that illustrate the accuracy of the two point method rejected by the Army. A, a foreign body embedded deep in a cylindrical block, a wax cylinder or a human leg, can be detected and its location indicated by one mark "X" on its upper surface and another on the under surface. The upper mark is readily made by any method, including the Army. The lower mark "X" is established by a ring marker that is moved about beneath the part until its image on the screen encircles the foreign body. Thus the foreign body is directly in line between the upper and lower marks "X." B, *roentgenologic caliper:* A convenient device or caliper for making the upper and lower marks at one time. By fluoroscopy or on a film one sees the ring marker, foreign body and square with the cross wires all in line, as shown in Figure 6. C, *surgical caliper:* A surgical instrument that is the counterpart of the x-ray caliper, is so designed that the distal end of the lower arm is attached to the skin at the lower mark "X" and then the part is adjusted so that the pointer at the distal end of the upper arm rests on the "X" on the upper surface. A knitting-needle-like pointer in the upper arm points directly to the lower mark and thus to the bullet and guides the surgeon to the foreign body. A stop on the pointer indicates the depth previously determined by a double shift of the tube, using any one of several mathematical formulas, or a sliding square to eliminate computation.

roll as he put pressure on the bit. Therefore, if not instructed otherwise, he would roll the block "on center," as shown in Figure 7E, and then bore straight down, because it would be more convenient for him to bore a hole with the block in that position, and in doing so he would miss the foreign body by a finger's breadth or more. So would the surgeon working on a leg put the leg in the most convenient position for his surgical approach, unless instructed otherwise. He would flex the knee slightly, rotate the leg outward, and like the carpenter with the bit, he would miss the bullet by the same distance as the carpenter would have missed it in the wooden cylinder. The Army officer did miss it in the wax model where this identical principle was involved. When only a single mark on the surface is used as a guide, this same source of error is present in all extremities and in irregularly spherical parts, such as the head which can be rotated in four directions instead of two or

The basic principle of the two-point method is shown in Figures 8A, B, and C. With the two-point method, two marks (two "X's") are made on the cylindrical block of wood or on the cylindrical wax model, or on the human part. (Fig. 8A.) One of these marks is on the upper surface and the other is on the undersurface, each in line with the foreign body, as observed fluoroscopically with the tube beneath the table. The mark on the upper surface would be recorded in exactly the same manner that it is the one-point method, but in addition to this if a ring pointer were placed beneath the part and moved into such a position that the shadow cast by it on the fluoroscopic screen perfectly encircles the image of the foreign body, and another mark were placed on the under surface of this part directly where the ring pointer was located, the two-point method of localization would be established. A line drawn through these two

points would transect the foreign body. (Fig. 8A.)

An x-ray caliper (Fig. 8B) has been designed and constructed to facilitate making both of these marks, one on the under surface and the other on the upper surface. The accuracy with which the roentgenologist does this is recorded on a small roentgenogram made either on film or on paper. Such a roentgenogram is shown in Figure 6 in which the two fragments of a needle are seen within the same field.

A companion surgical caliper (Fig. 8C) is so constructed that when it is adapted to the part by the surgeon, the part can be repositioned in exactly the same position that it was at the time the localization was done by the roentgenologist. This is accomplished by fixing the distal end of the lower arm of the surgical caliper on the under marker and repositioning the leg or part so that the distal end of the upper arm of the caliper rests exactly on the upper mark. Therefore, the foreign body must be in a direct line between the end of the upper arm and the end of the lower arm of the surgical caliper. In the upper arm of this caliper there is a knitting-needle-like pointer that acts as a guide to direct the surgeon toward the foreign body. Furthermore, there is a stop on the pointer which indicates the exact depth of the foreign body beneath the surface.

This surgical caliper was the instrument used by the Army officer in his successful search for the foreign body in the wax model and was also used by the surgeon in his successful search for the small fragment of needle in the shoulder.

A tabulated comparison of the new Army x-ray field unit and localizing device, and the one herein suggested is as follows:

One-point Army Method

1. Valuable only as a complete unit.
2. Localizing device and necessary equipment weigh approximately 1000 pounds.
3. The x-ray unit and localizing apparatus weigh more than a ton (estimated).
4. Can be shipped only by boat, train or truck.
5. Fluoroscopic examination only.

6. Can be used only in total darkness in lightproof and suffocating black tent.
7. Surgeon has only the roentgenologist's say-so in word description.
8. No mechanical device to guide surgeon.
9. Cost \$4,000 (approximate).
10. Speed for examination said to be 20 per hour.
11. Used for all kinds of x-ray work but patient must be brought to apparatus.
12. Fluoroscopy only; surgeon must take roentgenologist's word.

Two-point Method

1. Usable on any horizontal fluoroscope.
2. Localizing apparatus and film processing equipment weight approximately 50 pounds.
3. The x-ray unit and localizing equipment weigh approximately 150 pounds.
4. Can be flown anywhere.
5. Both fluoroscopic and roentgenologic examinations.
6. Used in any moderately light place, in the open if necessary, where one does not beg for air.
7. Surgeon can see size and shape of foreign body for himself.
8. Very accurate guide for surgeon.
9. Cost \$500 (estimate).
10. Speed same.
11. All kinds of diagnostic work, portable unit can be taken to patient without disturbing him.
12. Surgeon and roentgenologist can study roentgenograms together and segregate serious cases from simple ones.

If all these facts concerning the accuracy of the two-point method, its adaptability to any apparatus that may be available, its portability, low cost and its convenience be true, one would expect the Army to welcome this device as a solution to their perplexing problem of foreign body localization and extraction, especially in inaccessible places, but this is not the case.

Advice concerning the localization and extraction of foreign bodies could have been obtained by the Army from any one of scores of experienced roentgenologists throughout the country who had been trained intensively in the underlying principles of foreign body localization at one or another of the ten schools that were established with the consent of the Surgeon General in the previous war. These schools gave special training in foreign body localization and other phases of military roentgenology. The instructors were the most experienced roentgenologists of their time. Furthermore, hundreds of these men

had months and even years of actual experience in applying the basic principles during active service overseas in the first World War. Their advice, particularly the advice of those who had been specially interested in the subject of foreign body localization during the previous war was not sought. One fortunate fact, however, is that there are so many of these men still available to do accurate localizations in these boys after they are discharged from the army still carrying their foreign bodies.

An accessory device to the Army localizing unit is a horizontal marker used as a substitute for the biplane fluoroscopy. This device simply marks a point on the lateral surface of the body, at the depth of the foreign body from the upper mark. This apparatus is intended especially for the torso. The procedure is a step in the right direction but only a short one, because it does not aid the surgeon in repositioning the patient, and it offers him no accurate mechanical device to guide him directly to the foreign body.

In order to co-operate with the Army and to put at their disposal the apparatus and what experience had been gained in developing it, a full set of instruments, including a set of roentgen calipers, sliding square scale for determining the depth of the foreign body, a set of surgical calipers for aiding the surgeon in adjusting the part and the body, and the knitting-needle-like pointer to guide him, wax models for testing the accuracy of this apparatus, and a full set of instructions were sent. These

were to be used by the Army any way they saw fit, to test them out themselves or they were to have sent them to any one or any group of experts they desired. These instruments were sent on April 15, 1942, and returned June 21, 1942; but there was evidence that very little attention had been paid to them during this time.

It is not suggested to the Army that this two-point method should be adopted by them as a substitute for the method which they have specified. It is only suggested that the two methods should be set up side-by-side, at some place not in the Army school, and that all the data obtained by a series of competitive tests to show the accuracy of the two-point method compared with the one-point method should be recorded by a third party, and presented to a jury of totally unbiased civilians, not a court martial by Army officers, not even a trial by a jury of doctors, but a trial by a jury selected from a panel of good, hardheaded carpenters, plumbers, instrument makers with a few mothers who have boys at the front. They should be given the data and allowed to judge their value. For 150 years such a jury has been good enough to decide the question of life or death of thousands of persons; if it is good enough for that, such a jury is certainly qualified to make a recommendation to their Congressmen and Senators, especially if it is impossible to accomplish anything from within the Army—with thanks to Jim and Joe and others who have encouraged this revelation.



EARLY LAMINECTOMY FOR SPINAL CORD INJURY NOT DUE TO SUBLUXATION*

FOSTER KENNEDY, M.D.

Attending Neuropsychiatrist, Chief of Service,
Bellevue Hospital

PETER G. DENKER, M.D.

Associate Attending Neuropsychiatrist,
Bellevue Hospital

AND

RAYMOND OSBORNE, M.D.

Resident Neurologist, Bellevue Hospital

NEW YORK, NEW YORK

FOR the past century, neurologists and neurosurgeons have debated the indications for laminectomy in spinal cord injuries, and opinion is still divided. War experience should clarify, perhaps decide this controversy. It seems, therefore, timely to review the present state of the problem and give our own impressions on the subject, illustrated by enough case histories to be instructive.

HISTORICAL REVIEW

About a hundred years ago, Sir Astley Cooper and Sir Charles Bell were debating the value of laminectomy in spinal cord injury. Since then, the pendulum of opinion has swung back and forth between conservative treatment or operative intervention in these cases. At the moment most neurosurgeons are not enthusiastic over laminectomy in spinal cord injuries; neurologists, on the other hand, have frequently believed that their overcautious attitude is, in many cases, not justified.

From the experimental standpoint, the only work we were able to find in the literature was that of Allen¹ (1908 to 1911) which, unfortunately, has not been given the attention we believe this valuable contribution merits. Allen produced spinal cord injuries in dogs by means of an instrument whereby a given weight could be dropped from a known height to produce a given impact. Laminectomy was first performed in the lower third of the thoracic

region of anesthetized dogs. The instrument was then placed in position and the weight dropped on the cord. The resulting impact in Gram-centimeters was the product of the height in centimeters and the weight in Grams. As soon as an impact of 340 Gm/Cm was exceeded, spastic paraplegias were produced, which did not clear up spontaneously in the course of ten days as had the results of impacts of lesser severity. An impact of 450 Gm/Cm produced a picture of complete transverse lesion of the spinal cord resulting in the death of the animal in the asthenic-toxic state familiar to all with experience of severe spinal cord injuries in the human subject. In an attempt to determine whether this cessation of function was due to destruction of axis cylinders *directly* consequent to the impact, or *secondarily* following edema and hemorrhage into the cord tissue, which by its pressure and chemical activity resulted in ultimate cord degeneration, Allen made longitudinal section into the cord immediately after these injuries were produced. In the cases in which such incision was performed, the dogs made either a complete recovery or retained only slight awkwardness in the hind limbs, not enough to prevent running or jumping. Without operation, this impact would have resulted in the animal's death. From these experiments Allen believed that, in cases of fracture-dislocation of the spinal column in humans, in which

* From the Second Medical Division (Cornell) Bellevue Hospital, New York City.

had months and even years of actual experience in applying the basic principles during active service overseas in the first World War. Their advice, particularly the advice of those who had been specially interested in the subject of foreign body localization during the previous war was not sought. One fortunate fact, however, is that there are so many of these men still available to do accurate localizations in these boys after they are discharged from the army still carrying their foreign bodies.

An accessory device to the Army localizing unit is a horizontal marker used as a substitute for the biplane fluoroscopy. This device simply marks a point on the lateral surface of the body, at the depth of the foreign body from the upper mark. This apparatus is intended especially for the torso. The procedure is a step in the right direction but only a short one, because it does not aid the surgeon in repositioning the patient, and it offers him no accurate mechanical device to guide him directly to the foreign body.

In order to co-operate with the Army and to put at their disposal the apparatus and what experience had been gained in developing it, a full set of instruments, including a set of roentgen calipers, sliding square scale for determining the depth of the foreign body, a set of surgical calipers for aiding the surgeon in adjusting the part and the body, and the knitting-needle-like pointer to guide him, wax models for testing the accuracy of this apparatus, and a full set of instructions were sent. These

were to be used by the Army any way they saw fit, to test them out themselves or they were to have sent them to any one or any group of experts they desired. These instruments were sent on April 15, 1942, and returned June 21, 1942; but there was evidence that very little attention had been paid to them during this time.

It is not suggested to the Army that this two-point method should be adopted by them as a substitute for the method which they have specified. It is only suggested that the two methods should be set up side-by-side, at some place not in the Army school, and that all the data obtained by a series of competitive tests to show the accuracy of the two-point method compared with the one-point method should be recorded by a third party, and presented to a jury of totally unbiased civilians, not a court martial by Army officers, not even a trial by a jury of doctors, but a trial by a jury selected from a panel of good, hardheaded carpenters, plumbers, instrument makers with a few mothers who have boys at the front. They should be given the data and allowed to judge their value. For 150 years such a jury has been good enough to decide the question of life or death of thousands of persons; if it is good enough for that, such a jury is certainly qualified to make a recommendation to their Congressmen and Senators, especially if it is impossible to accomplish anything from within the Army—with thanks to Jim and Joe and others who have encouraged this revelation.



EARLY LAMINECTOMY FOR SPINAL CORD INJURY NOT DUE TO SUBLUXATION*

FOSTER KENNEDY, M.D.

Attending Neuropsychiatrist, Chief of Service,
Bellevue Hospital

PETER G. DENKER, M.D.

Associate Attending Neuropsychiatrist,
Bellevue Hospital

AND

RAYMOND OSBORNE, M.D.

Resident Neurologist, Bellevue Hospital

NEW YORK, NEW YORK

FOR the past century, neurologists and neurosurgeons have debated the indications for laminectomy in spinal cord injuries, and opinion is still divided. War experience should clarify, perhaps decide this controversy. It seems, therefore, timely to review the present state of the problem and give our own impressions on the subject, illustrated by enough case histories to be instructive.

HISTORICAL REVIEW

About a hundred years ago, Sir Astley Cooper and Sir Charles Bell were debating the value of laminectomy in spinal cord injury. Since then, the pendulum of opinion has swung back and forth between conservative treatment or operative intervention in these cases. At the moment most neurosurgeons are not enthusiastic over laminectomy in spinal cord injuries; neurologists, on the other hand, have frequently believed that their overcautious attitude is, in many cases, not justified.

From the experimental standpoint, the only work we were able to find in the literature was that of Allen¹ (1908 to 1911) which, unfortunately, has not been given the attention we believe this valuable contribution merits. Allen produced spinal cord injuries in dogs by means of an instrument whereby a given weight could be dropped from a known height to produce a given impact. Laminectomy was first performed in the lower third of the thoracic

region of anesthetized dogs. The instrument was then placed in position and the weight dropped on the cord. The resulting impact in Gram-centimeters was the product of the height in centimeters and the weight in Grams. As soon as an impact of 340 Gm/Cm was exceeded, spastic paraplegias were produced, which did not clear up spontaneously in the course of ten days as had the results of impacts of lesser severity. An impact of 450 Gm/Cm produced a picture of complete transverse lesion of the spinal cord resulting in the death of the animal in the asthenic-toxic state familiar to all with experience of severe spinal cord injuries in the human subject. In an attempt to determine whether this cessation of function was due to destruction of axis cylinders *directly* consequent to the impact, or *secondarily* following edema and hemorrhage into the cord tissue, which by its pressure and chemical activity resulted in ultimate cord degeneration, Allen made longitudinal section into the cord immediately after these injuries were produced. In the cases in which such incision was performed, the dogs made either a complete recovery or retained only slight awkwardness in the hind limbs, not enough to prevent running or jumping. Without operation, this impact would have resulted in the animal's death. From these experiments Allen believed that, in cases of fracture-dislocation of the spinal column in humans, in which

* From the Second Medical Division (Cornell) Bellevue Hospital, New York City.

there exists the symptom picture of transverse lesion of the spinal cord, "it were well to perform the operation of laminectomy at the earliest possible moment, and if the cord be not completely severed, to make a median longitudinal incision through the area of impact by means of a fine canalicular knife in order to drain the injured tissue of the products of edema and hemorrhage." Unfortunately, we do not know any comprehensive series of cases in the human in which this radical procedure has been thoroughly tested.

Alfred Taylor² advocated laminectomy in cases of fracture by direct violence, noting that such injuries usually involved the spinous processes and laminae. In such injuries, the bodies of the vertebrae remain intact; the cord damage results from direct impact of displaced bone fragments, as well as from resultant hemorrhage. In fractures produced by indirect violence, he admitted that it is impossible to determine at the start whether or not a permanent complete transverse lesion of the cord has occurred. Many "apparently transverse lesions show spontaneous improvement after weeks or months," and he advocated theoretically "a 'generous laminectomy, wide splitting of the dura and incision of the posterior columns of the cord for relief of hemorrhage and edema.'" Again, we are not aware of his use of this procedure in any series of cases.

Frazier³ was a strong advocate of surgical intervention in these cases of cord injury. Summarizing all statistics hitherto collected by various surgeons, a total of over seven hundred cases, he noted that "it is evident that, while the mortality is high both with or without operation, the percentage of recoveries or improvement is higher in the operated, than in the non-operated series." He admitted that these statistics were not to be accepted as decisive, pointing out that the cases upon which the late operation was performed, were those which had survived the immediate effects of the injury, and that they therefore, were a more favorable group for

operative intervention. Furthermore, he believed that the risk of early or immediate operation had been overestimated, and reported his own experience of twenty early operations with but one fatality. This solitary misfortune occurred in a fracture of the fifth cervical vertebra, "the patient succumbing on the fifth day, not because of the operation, but from involvement of the phrenic center." He was emphatic in pointing out that improvement in neurosurgical technic had been so great that one could reasonably expect a striking reduction in mortality rate. Prior to 1911, the operative mortality associated with laminectomy was 20 per cent, whereas from 1911 to 1915 it was less than 7 per cent. Most neurosurgeons will agree that today the operative hazard has been even more greatly lowered. Lastly, Frazier mentioned cases in his own clinical experience in which function had been recovered after operation, which, without operation, could not have been expected.

This old quarrel over the indications for laminectomy in spinal cord injuries was reviewed in a symposium of the Royal Society of Medicine in 1927. At this time, Jefferson,⁴ took a pessimistic view as to the value of laminectomy, believing that in most cases the cord is damaged by instant, irreparable, contusion and that too much was made of cord compression. To quote from Jefferson, "I will not go so far as to say pressure never occurs; in rare instances, it can be traced in gradually increasing amount. Such cases cry aloud for operation, but are exceedingly uncommon." In a later paper⁵ he again emphasized that in cord injuries, hematomyelia is rare, and that the cord swelling after trauma is more often due to "local neural disruption, to relatively bloodless contusion, rather than to intramedullary clot. The damage is in rupture of myelin sheaths, fracture of axones and nerve fibrils—and a distortion of the general cord pattern." Despite these severe underlying pathological alterations, Jefferson believed "the appearance of the cord in some fatalities leaves the impression

that the patient might have recovered if he could have survived the initial period of profound depression of function." He states he cannot recall a case in which complete motor and sensory loss was present, in which recovery occurred, but no mention is made as to the number of such patients he had operated upon with this purpose in mind.

Quoting the Medical Research Council study at this symposium, Riddoch,⁶ gave the following summary of their conclusions: (1) The full extent of cord damage is immediate. (2) Extramedullary hemorrhage is not a cause of cord compression. (3) In-driven fragments of bone, pressing on the cord, are passive agents not vital, or growing like a tumor. Increasing disturbance of function as a result of their presence is only secondary, due to fibrosis or loculation of cerebrospinal fluid. Their immediate removal is not necessary. The Council stressed the danger of operation during the period of "spinal shock," especially in the cervical and upper thoracic regions. They believed laminectomy should not be undertaken earlier than two to six weeks, and that it was only justified then, if there were gross bony deformity accompanied by incomplete cord lesion, or arrest of recovery, or severe and persistent root pain.

We shall later give our reasons for disagreeing with this passive pessimism. We believe in more intervention and less appeasement.

Mutuel and Rousseaux⁷ were strong advocates of early laminectomy, despite current conservative opinion. They believed that existing statistics could not establish the value of early laminectomy in cases of cord injury. All hitherto reported series of operated cases were open to criticism in that the statistics were old, were concerned with disparate facts, that the operative technic had improved and that, therefore, such material did not allow an opinion on the value of laminectomy. A similar point of view was expressed by Lériché,⁸ who considers that "all fractures of the spine, at whatever level

they may be, as soon as they are accompanied by neurological changes, ought to be immediately operated upon, without seeking to separate the phenomena of compression from destruction," because "if one knows how to do a laminectomy without useless trauma, without shock, under local anesthesia, it helps the patient and does no harm."

Lyerley,⁹ summarizing the indications for laminectomy, pointed out that the neurological examination can only reveal the degree of physiological interruption, but not the extent of anatomical lesion. He believed that the important indication for operation was cord compression, best indicated by manometric block, and that penetrating wounds, even without block, require operation.

Despite these helpful recommendations, and despite the continuing progress in spinal surgery, the surgeons for a decade have become more and more timid and fearful in their attitude toward these cases. Papers opposing early operative intervention have been written by Grant¹⁰ Lambrinudi,¹¹ Kleinberg,¹² Grinker,¹³ Elsberg,^{14a and b} Stookey,¹⁵ Scarff,¹⁶ Little,¹⁷ Brain,^{18a and b} Nielson,¹⁹ Verbrugghen,²⁰ Stinchfield,²¹ Taylor,²² Wortis and Sharp²³ and Browder and Grimes.²⁴ The Surgical Cliveden Set! Most of them believe it is useless to operate upon a patient with a *complete* transverse lesion following injury, yet as we well know we have absolutely no method of clinically distinguishing a complete "physiological cord block" from a block caused by "transverse destruction." The conservatives, as would be expected, also deprecate operation during the period of "spinal shock"—a wholly indeterminate condition. We believe this attitude quite pusillanimous.

However, these people have not had it all their own way. Contrary views *have* been advanced. Mock,²⁵ McLean,²⁶ Oldberg,²⁷ Wechsler,²⁸ Love,²⁹ Voris,³⁰ Munro,³¹ Coleman and Meredith,³² Stuck,³³ and Clark³⁴ have all doubted the wisdom of this policy of "watchful waiting." Of particular inter-

est is the report by Stetten³⁵ of a case seen by one of us (F. K.) in 1933, in which laminectomy had to be urged upon the surgeon despite the apparently complete transverse character of the severe cord injury. The case had been looked upon as hopeless. On operation, however, despite normal x-ray findings, "both laminae of the sixth cervical vertebra were found fractured; there was a depression of the fractured arch and a curved spicule of bone, $\frac{3}{4}$ cm. long, was discovered pressing on the cord." Four months after operation, the once totally paralyzed patient was able to walk off the ward with only a slight spasticity of gait. Stetten quotes Foerster, of Breslau, as advocating operation in all cases as soon as shock has subsided. (Note well, here, Foerster refers to "general shock." His mind was far too clear to harbor such cloudy conceptions as "spinal shock.") As to his own attitude toward laminectomy, Stetten states: "As a matter of fact, there is really no alternative. The operation is an extremely simple procedure, without any element of seriousness, and can easily be performed under local anesthesia." We agree, and this paper is wholly to say why.

ILLUSTRATIVE CASES

CASE I. J. L., aged fifty-four, an Italian laborer, admitted to the Bellevue Hospital Neurological Service on October 8, 1939, had fallen down a flight of stairs the previous afternoon, injuring his back. Immediately after the injury he noticed pain in the back of his neck, radiating down both arms. Twenty minutes later he felt uncomfortable sensations in his feet and lower legs and was put to bed at home. The paresthesias gradually spread up his legs and lower trunk and that afternoon urinary retention appeared.

All the limbs were weak, but the shoulder girdle muscles were of good power; the power in his hands was severely impaired. The legs were practically completely paralyzed. Deep reflexes were present in the arms, but diminished. The knee and ankle jerks were present on the right and could only be obtained on reinforcement on the left. The abdominal

reflexes were absent. The plantars were equivocal bilaterally. All sensation was lost below cervical six. The patient was not in shock.

Lumbar puncture was immediately performed; the initial pressure was 90 mm. of water. There was a complete block of jugular compression and amyl nitrite. X-ray of the spine revealed a fracture of the articular process of the seventh cervical vertebra and backward displacement of the body of the seventh cervical vertebra.

Surgical consultation was obtained and it was the opinion of the surgeons that no operation be performed, but that the patient be kept in hyperextension. The next twenty-four hours revealed definite progression of this man's paralysis.

Lumbar puncture was repeated on October 10th; manometric block was again found. The patient was then seen by one of us (F. K.) who advised laminectomy.

Operation was performed by Dr. J. Lawrence Pool on October 10, 1939, and consisted of laminectomy and removal of the arches of the fourth to the seventh cervical; the dura was opened longitudinally with exposure of the spinal cord. "Spinal cord was large, fusiform and yellowish. A small amount of clotted blood was found at the site." The cord was decompressed and the usual closure performed.

Immediately after operation power began to return in the legs and sensation slowly improved. At the end of four weeks the patient was able to stand. The legs were slightly spastic. The knee and ankle jerks were brisk, the left being greater than the right. Some weakness still persisted in the right hand. A slight reduction of sensation was found below the seventh cervical segment. Further improvement was gradually noted. The patient was discharged December 4, 1939, walking very well with only slight spasticity and needing no support. There was still a slight amount of weakness in the right hand. Sensation had improved markedly with a slight amount of hypalgesia present below Thoracic 3 on the right and Thoracic 10 on the left.

CASE II. F. K., a twenty-three year old tunnel worker, struck by a large boulder across his back on the morning of December 30, 1937, was immediately brought to Bellevue Hospital in shock. On examination he showed marked weakness in both legs, with hypalgesia and loss of sensation below Lumbar 2. The abdom-

inals were absent. The knee and ankle jerks could not be obtained. Vibration and position sense were lost in his legs. There was bladder and rectal incontinence and perianal sensation was also lost.

A lumbar puncture was performed. Spinal fluid was blood tinged. Complete manometric block was present. X-ray showed a comminuted compressed fracture of Lumbar 1, 2, 3, and 4 vertebrae. This was especially evident in the second lumbar vertebra which was completely split by the vertebra above it. There were also fractures of the seventh, eighth, ninth and tenth ribs on the right.

The patient rallied quickly from his initial shock, so that a laminectomy was performed by Dr. A. Kaplan that same day (December 30, 1937). The arches of the vertebrae Thoracic 12 to Lumbar 4 were exposed and the usual laminectomy performed. A good deal of liquefied blood infiltrating the superficial fascia was found dissecting the fascia away from the lumbar space. This blood did not clot. The fascia and muscles were stripped away subperiosteally from Lumbar 1 to Lumbar 3 inclusive, revealing a fracture of the second lumbar spine. Laminectomy exposed the dura, which, at its lower border, was found to be definitely constricted by a shelf of bone. The spines and laminae of Lumbar 1 and Lumbar 3 were also removed and the cord began to pulsate freely. A fine catheter was then introduced in both directions extradurally and no obstruction was encountered. The wound was closed in the usual manner.

Gradual improvement occurred; the patient began to void spontaneously in one week and the abdominal reflexes returned in two weeks. Power in his legs slowly returned, and the patient was out of bed in March 1938, gradually walking about. He was discharged on August 30, 1938, with excellent power in his legs and only a slight sensory change persisting below Lumbar 1 and 2 on the right. At the time of discharge, he was voiding well and had good control of the rectal sphincters.

CASE III. G. B., a seventeen year old Porto Rican girl, while quarrelling with her lover, was shot in the chest five weeks before admission to Bellevue Hospital, July 28, 1941. The bullet had entered her left breast immediately paralyzing her from her hips down. There was complete loss of sensation below the hips and the patient was unable to urinate. There was

complete rectal incontinence also. She was nursed expectantly for five weeks without improvement. The right leg was completely paralyzed, and motor power in the left leg much impaired.

Examination showed a flaccid paralysis of both legs, the right being more severely affected than the left. The patient was bedridden and could not stand without assistance. Knee and ankle jerks were absent. The lower abdominals could not be obtained and there was only a transient flicker of the left upper abdominal. No plantar responses were obtained. There was a complete loss of all forms of sensation below Thoracic 12 on the right; on the left sensation was markedly diminished to all forms below Thoracic 12, but not completely lost.

Lumbar puncture was done. The initial pressure was 65 mm. of water. There was an open manometric system. The total protein was 65 mg. Spinal fluid Wassermann and colloidal gold were negative. X-ray of the spine revealed a bullet still present over the right twelfth rib, $\frac{1}{2}$ inch from the vertebral body. There was a slight abnormality of the right edge of the twelfth thoracic vertebra suggesting a possible fracture.

Laminectomy was performed on August 5, 1941. The eleventh and twelfth thoracic vertebrae and the first lumbar vertebra were exposed. A depressed fracture of the transverse process of the twelfth thoracic vertebra was found, extending into the articular facet. "This fracture undoubtedly caused some compression of the cord." The dura was opened and many adhesions found at the site of this fracture on the right. A *small spicule of bone was found imbedded into the right cord*, and this was removed. The cord and the spinal roots at the level of Thoracic 11 and 12 were found adherent to the dura and these adhesions were freed. The dura was closed and the wound repaired in the customary manner. There was an uneventful healing.

There was a slow, but slight improvement in the power of the left leg, but the patient continued paralyzed to a major degree. Bladder control improved, so that tidal drainage was no longer required and it could be evacuated easily by the Credé method. Lumbar puncture was repeated August 30, 1941, revealing normal fluid with no spinal fluid block. The patient was discharged October 13, 1941, as slightly improved.

CASE IV. G. K., a twenty-one year old housewife, three months pregnant, while trying on a dress in a department store, tripped over a coat hanger and fell forward to the floor. She immediately noticed severe pain in the lower part of her back, which was thought to be a possible sacral sprain and she was strapped. X-ray taken at the time revealed no fracture. The pain persisted in the small of her back, radiating down her right buttock to the back of her right knee. One week later she suddenly noticed severe pain in both her ankles with numbness in her legs, followed almost immediately with complete paralysis of both her legs and bladder incontinence. The legs felt numb and "dead," and she could not move them from the bed, nor could she wiggle her toes. The patient was seen in neurological consultation by one of us (P. G. D.) on July 7, 1941, at the request of Dr. Robert Ackerly. There was a complete flaccid paralysis of both her legs and she could not lift her heels off the bed or wiggle her toes. Babinski sign was present with the fanning of the toes. The knee and ankle jerks were diminished, but bilaterally present and equal. Complete sensory loss to all forms of sensation was present below the second lumbar segment and perianal sensation was likewise completely lost. There was a band of hypalgesia extending from the level of the umbilicus to about the second lumbar segment. Above the umbilicus sensation was completely normal.

Urinalysis was completely normal. Red blood count 3,770,000 per cu. mm; hemoglobin 76 per cent, white blood count 9,900 per cu. mm. X-ray of the spine showed the thoracic and lumbar vertebrae completely normal. The patient was sent to the Post-Graduate Hospital where a lumbar puncture was performed, revealing a complete block. She was seen by Dr. John McLean in neurosurgical consultation on July 9, 1941. The neurological findings were the same as noted above and another lumbar puncture, with manometric determination, again revealed a complete block.

Laminectomy was performed on July 10, 1941, under local anesthesia. The cord was exposed by removal of the spines of the seventh, eighth and ninth thoracic vertebrae and seemed slightly swollen, but no gross defect could be noted. The dura was incised and slight vascular dilatation of the pia-arachnoid vessels observed, but no gross clot found. Gentle aspiration with

a fine needle between the posterior columns revealed little of consequence. The outlook seemed grave indeed. Nothing of sufficient importance had been observed to make one believe that surgical procedure would be likely to aid the patient. It was thought that probably an intramedullary lesion had been sustained at the time of injury and that surgical intervention had been of little help. The next morning, however, to everyone's astonishment, the patient was found to have improved markedly and was able to lift her heels off the bed, abduct her legs slightly and wiggle her toes. A slight return of sensation was also observed in her legs. From this time onward improvement was very rapid, so that the patient was discharged from the hospital, with a slightly spastic gait, within two weeks, going through a rapid convalescence thereafter. In October, 1941, no neurological signs could be obtained, except for a slight band of hypalgesia below the umbilicus from Thoracic 10 to Thoracic 12 inclusive.

Nor was the pregnancy interrupted; the patient gave birth to a normal child in December, 1941.

The patient was seen for the last time on January 10, 1942, stating she had remained perfectly well, walking about normally with no impairment of bladder or rectal control. The only neurological finding noted, as above mentioned, was a persistent band of hypalgesia from Thoracic 10 to Thoracic 12.

CASE V. A man of thirty-five was admitted to the Hospital, with a history of a blow to the back of his neck by a blackjack (?) the previous afternoon. He was immediately rendered unconscious with quadriplegia and incontinence. On examination, complete paralysis of all four limbs was present with loss of sensation to all modalities below the fifth cervical dermatome. X-rays of the spine were negative. This patient was seen in consultation by one of us (F. K.) five days after the injury because no improvement had occurred during this interval. He had been viewed as hopeless since it was believed that a complete transverse cord lesion was present. Operation was advised and laminectomy performed (Dr. DeWitt Stetten) on the sixth day following his injury, revealing "a fracture through both laminae of the sixth cervical vertebrae with slight depression of the fractured arch and blood extravasation around

the fracture lines. A curved spicule of bone $\frac{3}{4}$ cm. long was found pressing on the cord."

Three days after the operation, slight power in his lower limbs had returned, and on the fourth day it was noted that there was some movement in the arms. On the tenth day postoperatively, there was beginning return of sensation. From this time onward, continued improvement occurred so that four months after the injury, the patient was able to walk about the ward without any help, despite a slight persistent spasticity in his lower limbs.

DISCUSSION

Why do we favor early laminectomy in spinal column and cord injury, where the site of injury can be diagnosed?

1. Clinically, it is impossible to determine from the neurological examination at the time of the accident whether the cord has been completely severed, or whether function has been physiologically interrupted, (so-called "spinal shock"). We have repeatedly seen cases in which it was believed that a permanent, complete, transverse cord lesion had occurred, yet function, in varying degree, returned, despite an apparently hopeless prognosis at the start. Frazier,³ Lambrinudi,¹¹ Verbruggen,²⁰ Lysterley⁹ and others, agree with this observation. As Hamilton Bailey³⁶ has observed, "such paralysis does not signify that there is a complete lesion of the cord. Indeed it does not necessarily imply that the cord has been macroscopically damaged at all. . . ." Taylor² adds, "It is impossible to determine at the start whether or not it is a permanent, complete transverse lesion of the cord substance, since many apparently complete transverse lesions show spontaneous improvement after weeks or months." Allen's¹ experimental work on dogs, described above, is, in our opinion, conclusive evidence that this clinical observation is sound and true.

We stress these observations in some detail, since most neurosurgeons are reluctant to operate upon patients with so-called "complete transverse lesions" of the cord. Since all one can determine from the neurological examination is information as

to the degree of *physiological* interruption in the spinal cord pathway, but not the degree of *anatomical* destruction, we believe that this argument in favor of conservative treatment, has almost no weight at all.

2. X-rays of the spine are by no means conclusive of fracture of the laminae or the spines, and, as our case reports III and V show, spicules of bone may be pressing on the cord without appearing on the x-ray film. After autopsy observation, Browder and Miner³⁷ in their interesting article, found that "negative x-ray findings do not necessarily exclude the possibility of a bone lesion." Many other good observers have said the same. As so often happens in laboratory medicine, positive data may be conclusive, whereas negative findings are not exclusive.

3. Cord compression, as shown by the finding of a manometric block (Queckenstedt) on lumbar puncture, is of course vital. It demands laminectomy. A manometric determination should always be done in the presence of a cord injury, despite objections by some observers as to the possible danger of this procedure. Admitting the slight hazard of manipulation of such injuries, this risk is truly little if proper care be taken. It must also be recalled that the manipulation associated with reduction is certainly not without its hazards, and this danger has been repeatedly stressed in the literature by such men as Munro³¹ and others. In our thirty years of experience at Bellevue with such cord injuries, we have yet to see a fatality produced by careful lumbar puncture and manometric determination.

It can not be too strongly stressed that, in contrast to the increase in general intracranial pressure associated with head injuries, compression of the cord is here sharply localized. The level of cord involvement can usually be easily determined by simple clinical means. It is, therefore, reasonable to expect relief from laminectomy performed directly at the area of compression.

4. With the perfection of neurosurgical technique in the past generation, the operation of laminectomy has become less dangerous by a good deal than is a diagnostic laparotomy. We have already quoted Leriche,⁸ Stetten,³⁵ Frazier³ and others, regarding the safety of this procedure. Certainly, when one faces the gravity of this condition, likely to cripple and shorten life, the small operative mortality associated with laminectomy should weigh little in the decision.

5. Even the conservative surgeons, despite themselves, have had their successes. Occasionally, dramatic cases of improvement following laminectomy have been observed: Elsberg,¹⁴ Davidoff,³⁸ Grant,¹⁰ etc. The argument that a similar result might have resulted after conservative treatment seems beside the point, since a well controlled, conclusive series has not been obtained. Our Case iv is illustrative. Even if only one case in a hundred were helped by laminectomy and saved from a life of helpless invalidism, this operation should be resorted to, since no other choice is open. The situation is one in which there is nothing to lose and everything to gain, even if it be admitted, which we do not admit, that it is only the rare case that can be aided by operative intervention. We are aware of the unusual experience of a surgeon in which laminectomy revealed a pulped cord, which, on splitting the dura, was extruded like ooze. In such cases, though the operation was of no help since the cord was irretrievably damaged in the first place, it did no harm.

No statistically valid series has yet been reported in which similar patients were alternately treated radically and conservatively (by laminectomy or by traction). We advocate such a study, which should be conclusive.

6. If operation be decided upon, laminectomy should be performed early. These cases are surgical emergencies. As soon as, in the judgment of the operating surgeon, the patient is sufficiently out of general shock and able to withstand the procedure,

let him waste no more time. Frazer³ stated roundly, "if the operation is to be performed at all, it should be done at the earliest possible moment; . . . the risk of early or immediate operation has been overestimated if my own experience be any criterion, since in a series of twenty operations there has been but one fatality." Grant¹⁰ also believed that time is the essence of the problem, stating that "unless existing pressure on the cord is relieved within eighteen hours, damage will be permanent." Though the arbitrary time limit may be open to question, as is demonstrated in our illustrative cases, we agree completely regarding the need of early intervention.

The arbitrary statements about a waiting interval of from two to six weeks to allow "spinal shock" to subside are sheer nebulosities and need no longer hamper action.

SUMMARY AND CONCLUSIONS

1. The literature of fractures of the spine with spinal cord injuries has been reviewed.

2. Indications for laminectomy in spinal cord injuries have been discussed; more frequent operative intervention has been advocated for these reasons: (a) It is impossible to determine clinically, whether an apparently complete transverse lesion of the cord is not really a temporary physiological interruption of function. (b) Negative x-ray findings cannot for certain exclude a bony lesion of the spine. (c) Prolonged cord compressions, as manifested by manometric block, can destroy cord function, and its early relief by surgery may cure. (d) The operation of laminectomy is associated with little risk.

3. No statistically valid series of cases exists, in which the patients were alternately treated by laminectomy or conservative régime. We advocate such a study.

4. If operation be decided upon, laminectomy should be performed early. These cases are surgical emergencies.

REFERENCES

1. ALLEN, ALFRED R. Surgery of experimental lesions of spinal cord, equivalent to crush injury of fracture dislocation of the spinal column. *J. A. M. A.*, 57: 878, 1911.
2. TAYLOR, ALFRED S. Is early operation indicated in fractures of the spine with cord symptoms? *New York M. J.*, 107: 583-585, 1918.
3. FRAZIER, CHAS. H. Surgery of the Spine and Spinal Cord. New York and London, 1918. D. Appleton & Co.
4. JEFFERSON, GEOFFREY. Discussion on spinal injuries. *Proc. Roy. Soc. Med.*, (Sect. Orthop.), 21: 637, 1928.
5. JEFFERSON, GEOFFREY. Concerning injuries of the spinal cord. *Brit. M. J.*, 2: 1125, 1936.
6. RIDDOCH, G.: Discussion on spinal injuries. *Proc. Roy. Soc. Med.*, (Sect. Orthop.) 21: 643, 1928.
7. MUTUEL and ROUSSEAU. La Laminectomie Précoce dans les fractures vertebrales dorsales et lombaires. *Gaz. méd. de France*, 8: 276-281, 1933.
8. LECÈNE et LÉRICHE. Thérapeutique Chirurgicale. Vol. 2, p. 353. Paris, 1926. Masson.
9. LIVERLEY, J. G. The management of acute spinal cord injuries. *J. Florida M. A.*, 20: 153, 1933.
10. GRANT, F. C. In Christopher's A Text Book of Surgery, p. 326. Philadelphia, 1936. W. B. Saunders Co.
11. LANBRINUDI, C. Fractured vertebrae. *Guy's Hosp. Gaz.*, 50: 39-50, 1936.
12. KLEINBERG, S. Fracture of the spine. *Am. J. Surg.*, 33: 85-100, 1936.
13. GRINKER, ROY. Neurology, p. 782. Springfield, Ill., 1934. Chas. C. Thomas Co.
14. ELSBERG, CHAS. (a) Diseases and Surgery of Spinal Cord. In Nelson's New Loose-Leaf Surgery, p. 437, New York, 1937. Thos. Nelson & Sons. (b) Injuries of Spinal Cord and Nerve Roots. In Brock Injuries of Brain, Skull and Spinal Cord, p. 520. Baltimore, 1940. William Wood & Company.
15. STOOKEY, B. The management of fracture dislocations of the vertebrae associated with spinal cord injuries. *Surg., Gynec. & Obst.*, 64: 407-419, 1937.
16. SCARFF, J. E. Pathology and treatment of spinal injuries. *New York State J. Med.*, 37: 461-477, 1937.
17. LITTLE, NORMAN. Fractures of the spine with special reference to laminectomy. *Med. J. Australia*, 25: 89, 1938.
18. (a) BRAIN, W. R. Diseases of Nervous System. P. 616, London, 1940. Oxford Univ. Press. (b) BRAIN, W. R. and STRAUS, E. B. Recent Advances in Neurology. P. 140. Philadelphia, 1930. P. Blakiston & Sons.
19. NIELSON, J. M. Text Book of Clinical Neurology. P. 541. New York, 1941. Paul B. Hoeber.
20. VERBRUGGHEN, ADRIEN. Spinal cord injuries. *South Clin. North America*, 20: 269, 1940.
21. STINCHFIELD, F. E. Fractures of the vertebrae. *Surg., Gynec. & Obst.*, 70: 378-388, 1940.
22. TAYLOR, J. Discussion on war injuries of the spine. *Proc. Roy. Soc. Med.*, 34: 447, 1941.
23. WORTIS, S. B. and SHARP, L. I. Fractures of the spine. *J. A. M. A.*, 117: 1585-1590, 1941.
24. BROWDER, J. and GRIMES, R. Treatment of fracture of the spine with and without neural injury. *New York State J. Med.*, 42: 866-873, 1942.
25. MOCK, H. E. Management of fractures of spine. *Internat. J. Med. & Surg.*, 46: 451, 1933.
26. MCLEAN, A. J. Fractures of vertebrae with spinal cord lesions. *Northwest Med.*, 34: 84, 1935.
27. OLDBERG, E. Neurosurgical considerations of fractures of spine. *Surg. Clin. North America*, 16: 291-302, 1936.
28. WECHSLER, I. S. A Textbook of Clinical Neurology. 4th ed. Philadelphia, 1939. W. B. Saunders & Co.
29. LOVE, J. G. Fractures of the spine involving the spinal cord. *Surg. Clin. North America*, 17: 1103-1114, 1937.
30. VORIS, H. C. Fractures of the spine. *Surg. Clin. North America*, 17: 543, 1937.
31. MUNRO, D. and WEGNER, W. Bone lesions accompanying cervical spinal cord injuries. *New England J. Med.*, 222: 167-173, 1940.
32. COLEMAN, C. C. and MEREDITH, J. M. Treatment of fracture dislocation of the spine associated with cord injury. *J. A. M. A.*, 111: 2168-2172, 1938.
33. STUCK, R. M. Spinal injuries with nerve damage. *Southwest. Med.*, 24: 157-160, 1940.
34. CLARK, W. A. Fractures and dislocations of the cervical portions of the spine. *Arch. Surg.*, 42: 537, 1941.
35. STETTEN, D. W. Decompressive laminectomy with fracture of sixth cervical vertebra with almost complete quadriplegia. *Ann. Surg.*, 97: 281-285, 1933.
36. BAILEY, HAMILTON. Emergency Surgery. 4th ed. Bristol, 1940. John Wright & Sons.
37. BROWDER, J. and MINER, T. Fractures of the spinal column. *West Virginia M. J.*, 30: 11, 1934.
38. DAVIDOFF, L. M. Spinal cord injuries. *Surg. Clin. North America*, 21: 433, 1941.



MULTIPLE CARCINOMA*

THE CLINICAL PICTURE, DIAGNOSIS AND PROGNOSIS

HUGO HELLENDALL, M.D.

NEW YORK, NEW YORK

THE literature on multiple carcinoma is extensive but does not include any review of all the published material on the clinical picture, diagnosis and prognosis. Multiple primary carcinoma occurs in different organs and organ systems. Therefore, the clinical picture, the diagnosis and prognosis of multiple carcinoma are quite different in different cases. That may be the reason why a summary description is absent in the extensive literature of multiple carcinoma. For instance, the monographs of Warren and Gates,¹ Anderhub,² Cokkinis,³ H. E. Bacon⁴ and others do not mention them at all. I think it is very worth while to try to give such a description of the clinical picture, diagnosis and prognosis of multiple carcinoma.

Frequency. At the Presbyterian Hospital multiple primary cancers occurred in thirty of 685 autopsies upon cancer cases, i.e., 4.33 per cent. This is in fair agreement with the statistics in the literature. Warren and Gates in a study of recorded cases found a general incidence of 1.84 per cent, and in their own series of 1,078 cancer cases, the frequency was 3.7 per cent. Hurt and Broders⁵ found 3.34 per cent in 2,124 cancer patients.

Classification. According to *site* three cases arose in the same organ (stomach, colon, breast). In twenty-four of the thirty cases, one of the tumors originated in the digestive tract; and in eleven of the thirty cases, the multiple cancers arose exclusively in the digestive tract. Among a total of 685 autopsies upon cancer cases, there were 295 cases (43.06 per cent) in which the cancer was primary in the gastrointestinal tract. There is thus a decided predisposi-

tion toward the formation of multiple primary tumors in the digestive tract.

According to *time* of appearance twenty-one cases, including three which are uncertain, have been synchronous, and nine (one uncertain) metachronous.

According to *histologic structure* in four cases the primary cancers presented an identical histologic structure, in twenty-six a diverse one. In twenty-four cases, the multiple growths were carcinomatous; in one case, a sarcoma and carcinoma occurred simultaneously; in another case, there was a mixed carcinosarcoma.

There were no significant conclusions to be derived from an analysis of sex, age or race. Familial incidence was no higher in the cases of multiple tumors than in the single ones.

Congenital anomalies were found more frequently in cases of multiple cancers than in single cancers or in noncancerous patients. The relative incidence of anomalies in these three groups was seventy-seven multiple, sixty-six single, and fifty noncancerous. There was also a higher incidence of multiple *benign* tumors in the individuals bearing multiple primary malignant tumors than in the single cancer cases or in the noncancerous subjects. The proportional incidence for the three groups was fifty-eight multiple, twenty-four single, and thirty-three noncancerous.

In 1916, Harbitz⁶ emphasized the fact that carcinoma is quite often found in association with one or more tumors having congenital background. Rössle,⁷ in 1920, made similar observations on a large amount of material, and expressed the opinion that the association of cancer with

* From the Constitutional Clinic and the Department of Pathology, College of Physicians and Surgeons, Columbia University, New York City.

benign tumor and anomalies is so much greater than the expected frequency as to point to a constitutional predisposition. Siebke,⁸ in 1926, on the basis of the writings of Rössle, Harbitz, Bartel,⁹ Egli,¹⁰ Swilen-ski¹¹ and others, came to the conclusion that multiple cancers are of great interest and importance from the point of view of constitution. He urged the reporting of benign tumors, hematoma and malformations in such cases, as well as the recording of their absence. This suggestion has been carried out by Anderhub in his two negative cases. According to Cokkinis, the figures quoted by Warren and Gates show that the incidence of multiple primary malignancy is many times greater than the calculated incidence based on chance. John C. Bugher¹² says that there is an inherent susceptibility to cancer not possessed by all people, and Carl V. Weller¹³ agrees with him. The nature of this predisposition according to Warren and Gates is unknown.

Congenital anomalies have occurred more frequently in our thirty cases of multiple cancer than in single ones, or in noncancerous cases. This may support the idea that the cells which give rise to cancers may themselves be congenitally abnormal. *Heredity* may be an intrinsic factor in the origin of multiple tumors. Recklinghausen's hereditary multiple neurofibromatosis, associated with deafness, bilateral acoustic tumors, multiple meningiomas and gliomas in various combinations (Cushing¹⁴) is an example.

Hormonal stimuli may be another significant factor in the origin of multiple tumors and cancers. Dyshormonal influences are assumed in cases of cancer of the breast, the uterus, the ovaries (Sampson) and possibly the prostate.

It may be that, under certain circumstances, congenital anomaly, heredity, or hormonal stimulus, may separately or in combination with each other lead to the formation of multiple carcinomas.

A review of the clinical data of our thirty cases of multiple cancers gave no certain

evidence of any hereditary or dyshormonal influence. Regular assays of blood and urine for sex hormones in cases of multiple cancers may give in the future more evidence of dyshormonal disorders. Following the experimental work of Davidson,¹⁵ Genkin and Dimstruck,¹⁶ Murray, Woglom and Cramer¹⁷ it has to be established by new experiments whether it is possible to produce multiple cancers similar to that found in the human body by means of hormonal stimulation.

The material of the thirty multiple primary cancer cases on the basis of autopsy mentioned above will be used for the description of the clinical picture and diagnosis of this disease. Moreover, thirteen other only clinically observed cases of multiple cancers, of which five are living and eight are dead, will be used to give a picture of the *prognosis* of the disease of multiple cancers.

CLINICAL PICTURE

We have to separate the synchronous cases from the metachronous. Multiple primary cancers are *synchronous* when they are present simultaneously. Multiple primary cancers are *metachronous* when they originate after the operation of a first cancer. The clinical picture of these two kinds of multiple cancers is different.

Multiple cancers affect the host just as any cancer does. But the clinical picture of multiple cancers must be different from that of single cancers. The clinical picture of twenty-one synchronous cancers will be treated first, showing (1) the general effect on the vital powers as a whole, (2) the local effect, which may produce a general effect, and (3) the effect of metastases. It is clear that if two or more primary cancers originate in different parts of the same organic system or in different organic systems, very different effects may appear in the clinical picture than would appear if the cancers were in the same place.

An *intestinal obstruction* produced by two different cancers on two different parts of the bowel may produce an especially

stormy picture. A second example of a double effect by a mechanical obstruction of the lumen of two different hollow organs by double cancers was found in one of our cases. Here the right bronchus was narrowed by a cancer and the right ureter was shut by a tumor of the urinary bladder. The clinical picture was characterized by asphyxia and a hindered discharge of the urine.

If a cancer produces a perceptible, clinical effect by a stricture, we may be justified in suggesting also a simultaneous biochemical effect (that is, an alteration of metabolism, loss of weight, cachexia, etc.) due to those cancers accidentally found in the same cases at autopsy and which were not diagnosed clinically. Such an example is that of a patient in whom there was a carcinomatous stricture of the sigmoid and a clinically undiagnosed annular crater of the duodenum.

Another kind of mechanical and simultaneous biochemical effect may result from double cancers, if they both invade the same organ and so eliminate in a mechanical way tissues which are useful for the general biochemistry of the body. In one of the cases in this series there were dyspnea and orthopnea caused by two independent cancers in the lower lobe of the right lung.

The *formation of metastases* influenced strongly the picture of the disease of multiple cancers in other cases. In one case an ulcerated, inoperable cancer of the breast with extensive metastases in the axillary glands lasted a year. It was associated with a cancer of the rectum, which made a stricture of the bowel of three months' duration, and ended with extensive metastases in the cavities of the peritoneum and the chest, with perforating peritonitis.

In another case the obstruction of the bowels was explained by a clinically diagnosed cancer of the rectum (polyp), but the numerous metastases to the liver, which gave the characteristic feature to the clinical picture by their violent pain in

the epigastrium, originated from a cancer of the head of the pancreas, found only at autopsy.

In still another case a clinically diagnosed cancer of the fundus of the gallbladder or the tumor in the region of the gallbladder probably explained the constant pain in the right upper quadrant. But the general peritoneal cancer with ascites and the extensive metastases into the liver and the lungs which arose from a cancer of the great curvature of the stomach, found only at autopsy, may also have been responsible for the constant pain. In any case, the metastases would certainly have made the pain greater.

In one of the cases in this series the icterus gravis was produced by a cancer of the bile duct with a large node in the right lobe of the liver and with regional lymph gland metastases. The extensive spreading carcinoma of the peritoneum, which added to the especially serious character of the clinical picture, originated in a cancer of the right ovary. This was not diagnosed during life, and not recognized at autopsy but was discovered later by the microscopic examination.

The following data are characteristic both as a clinical picture of metastasis and from a pathological standpoint: In this patient the disease lasted thirty-one years. The patient had had a pruritus-ani first, then she had four primary cancers in the anal region within ten years. In the eleventh year she had a biopsy of the uterus, which showed a beginning cancer of the cervix. This cancer was healed locally by x-ray, but then she showed the picture of a general carcinoma of the peritoneum probably caused by a carcinomatous occlusion of the thoracic duct. In the meantime, half a year before death, she had a growth in the left supraclavicular region, which looked like a carcinomatous Virchow gland. But after an aspiration of fluid with no cancer cell tissue, it was thought to be a varix of the thoracic duct. Later on, however, the microscopic examination of the tumor removed at autopsy showed cancer, not

only in the lumen and the wall of the thoracic duct but also in the nodule mentioned above which was the remains of

The clinical picture was also complicated occasionally by diseases, which were independent of the cancer: The clinical picture

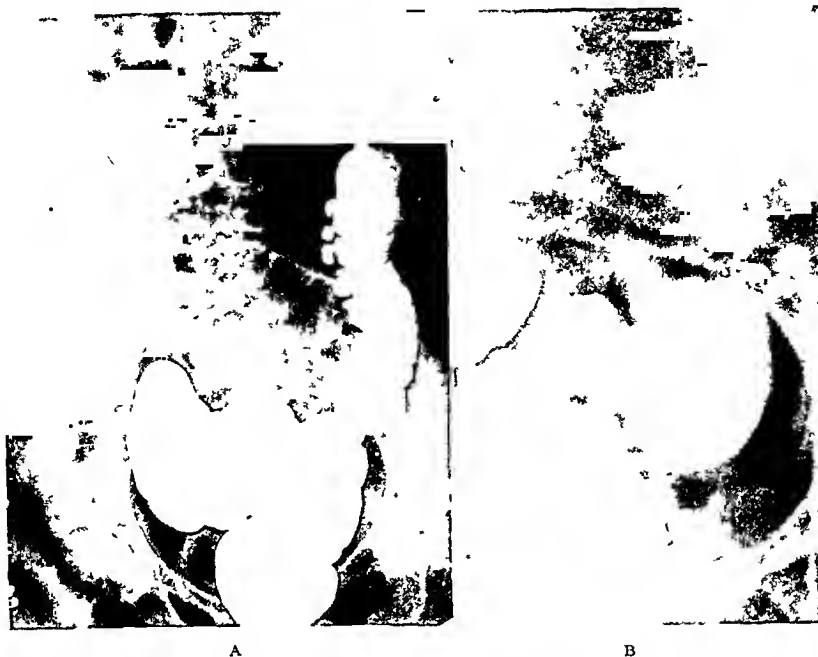


FIG. 1. A, shows a complete obstruction at the splenic flexure and distention of small enlarged intestine proximal to the lesion. In addition numerous diverticula of the descending colon are seen. B, a spot film shows irregularity and constriction of the lumen at the junction of the sigmoid and descending colon.

a lymph gland. Hence, it was a carcinomatous Virchow gland replaced by metastases and adjacent to an enlarged part of the thoracic duct.

In other cases there were complications caused by the cancer itself which changed and influenced the clinical picture. Twice a biliary cirrhosis of the liver as a result of the cancer was found: (1) In one case three weeks before death, an icterus gravis suddenly occurred. The biopsy showed a biliary cirrhosis of the liver. The cause was a cancer of the head of the pancreas, which obstructed the choledochous duct. (2) In another case an unknown cancer of the esophagus had metastasized in the retroperitoneal lymph gland. This large tumor mass obstructed the choledochous duct and produced a biliary cirrhosis of the liver. Hence, the presence of icterus gravis, the white diarrhea and the extensive ascites.

in one case was characterized by (1) symptoms in the lung starting from the cancer of the lung, and (2) complication of a progressive paralysis of the right half of the body and of the speech center caused by a left meningioma, which pressed and necrotized the left central lobe of the brain. The simultaneous sigmoid cancer produced no clinical symptoms. Metastases of the lung cancer in the occipital lobe of the brain had not changed the clinical picture.

Finally, there are the data of the clinical picture of synchronous multiple cancers which occurred in a man who had reached the age of seventy-two years with: (1) bronchiectasies in both lower lobes, (2) a moderately developed cirrhosis of the liver, (3) a fresh tuberculosis peritonitis with miliary tubercles in the spleen, the liver and an epigastric lymph gland, in which were found a moderate number of tubercle

bacilli, and (4) three primary multiple cancers.

The appearance of the metachronous

There may be rare exceptions¹⁸ and it is interesting to read that according to Cramer there is a great difference between

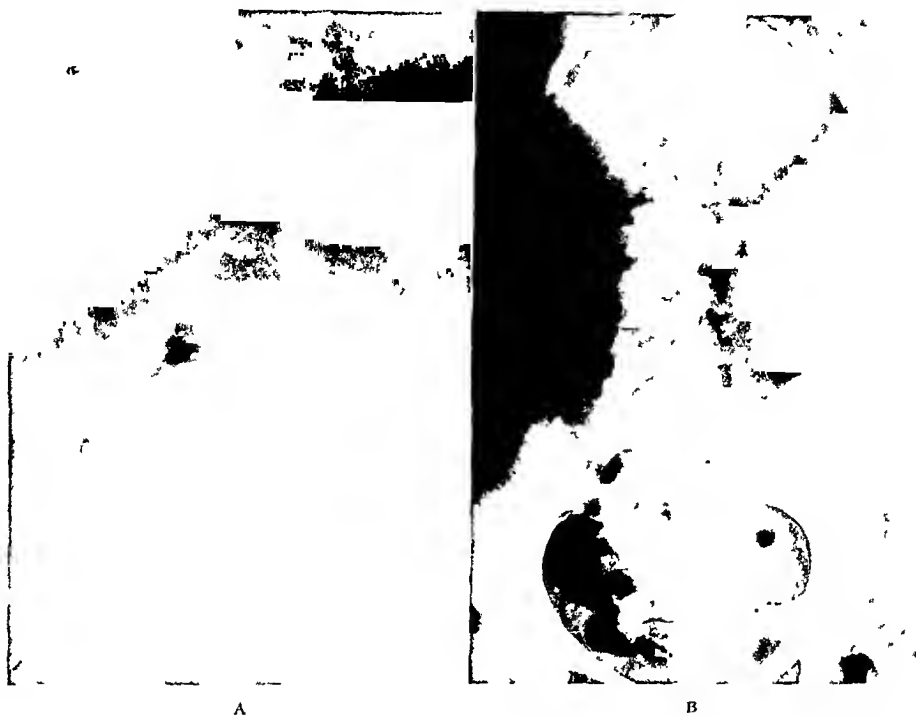


FIG. 2. A and B, show a constricting lesion of the sigmoid and in addition polyps of the rectum.

cancer occurred within periods ranging from fourteen days to sixteen years after the establishment of the first cancer. The first cancer occurred seven times in the digestive tract in the nine cases of metachronous cancer, i.e., 77.80 per cent of all. Of these 7 cases, the first and the metachronous cancers developed five times in the digestive tract, and twice the first cancer was in the digestive tract and the metachronous cancers were in the bronchus or in the urinary bladder.

Carcinomatous strictures occurred in six cases; four times in the first and the metachronous cancer, once in the metachronous cancer only, and once in the first cancer. It shows the important part played by stricture formation in metachronous cases and the importance for the clinical picture.

The loss of weight and the curtailed duration of human life are in general a result of the growth of the cancer itself.

animals and human subjects.¹⁹ Hence whatever may be the cause of cachexia in cancer bearing patients, it is apt to be more extreme in cases of multiple than of simple cancers. In twelve cases of synchronous multiple cancers, which offered a clinical picture influenced by two or more multiple cancers, eight showed great weight loss. In four cases there was weight increase due to fluid in the pleural, pericardial and peritoneal cavities.

A. P. Stout²⁰ has given the average duration of life for a number of cancers but not for multiple cancers. Our cases of multiple cancers were compared with the average numbers of Stout, wherever they were available. The attempt was made to find out if there were any great differences and if it were possible to draw any conclusions from them. We have seen, that in eight synchronous cases of the twenty-one, which had multiple cancers, the duration of life had been shortened consider-

ably, as compared to the average figures for duration which Stout has given us. In this connection it seems irrelevant that Stout has given us only the average duration of *one* cancer in most of these multiple cancer cases; but it must be pointed out that in all eight cases there were no other complicating causes of death, independent of the cancer itself. *This shortening of the duration of life can be explained only by the synchronous effect of the multiple cancers on the body.*

accelerated by synchronous multiple cancer cases as compared with corresponding metachronous cases. That may be the simultaneous effect of multiple cancer on the body.

RELATIONSHIP OF POLYPOSIS UNIVERSALIS TO MULTIPLE CANCERS OF THE DIGESTIVE TRACT

The question of *polyposis universalis* of the digestive tract was raised only in three

TABLE I*

Case	Metachronous Cancer	Duration of Life	Case	Synchronous Cancer	Duration of Life
15	In the colon transv. after former cecum ca. 16 years before.	10 months	1	3 Multiple colon ca.	3½ months
30	In the cecum after former ca. of splenic flexure a ca. of rectum 14½ mo. after 1st operation.	9 months	1	3 Multiple colon ca.	3½ months
3	In the sigmoid after former appendix ca. 3-years and 2 mo. before.	2¼ months	22	1. Sigmoid ca. 2. Ca. of bile duct.	1¼ months
25	In the esophagus after former ca. of tonsil. 3½ years after healing by x-ray.	13¾ months	2	1. Esophagus ca. 2. Stomach ca.	6¼ months
26	In the bronchus after former breast ca., 2½ years after mastectomy.	21 months	4	1. Ca. of bronchus 2. Ca. of bladder	12 months

* Due to lack of space lengthy tables submitted originally with this article have not been included.

If this is correct, we may expect a *greater duration* of life in the *metachronous* cases of multiple cancer, because only one is effective at a time. Indeed that is the case in five instances. Table 1 shows the greater duration of life in five metachronous cases of multiple cancers in relation to five corresponding synchronous cases of multiple cancers.

In three of these five metachronous cases it was noticed that the loss of weight was smaller than in the corresponding synchronous cases of multiple cancers. This small series is reported here in hopes that similar observations may be made in a larger series. But even this small group of cases creates the impression that the duration of life is shortened and weight loss

metachronous cases: (1) In one numerous benign polyps occurred in the colon, and neither the cancer of the appendix nor the cancer of the sigmoid showed any microscopic relation to the formation of polyps. (2) In another case the cancer of the jejunum itself showed an apparent relation to the formation of polyps; however, the earlier cancer of the cecum and the later cancer of colon ascendens did not show this relationship. Other polyps were absent. (3) In a third case there were five cancers of the intestine, three of which were metachronous colon cancers. The metachronous cancer of the cecum turned out to be a large carcinomatous polyp. Two other small, early carcinomatous polyps occurred close by. But also the cancers of the splenic

flexure and of the rectum resected one and one-half years before showed microscopic relations at that time to the polyp forma-



FIG. 3. Shows a mass in the left lower hilar region, diagnosed by Dr. Ross Golden as a primary cancer of the bronchus. Autopsy confirmed this finding.

tion. Other single polyps did not occur anywhere in the intestine.

INFLUENCE OF MULTIPLE CANCERS ON THE BLOOD

The question to be investigated was whether the influence of cancer on the blood would appear stronger in the multiple cancers than in single ones. We know that cancer is followed often by an anemia, which occasionally tends to resemble the pernicious type. Hence, the hemoglobin percentage and the number of red blood corpuscles of the thirty multiple cancers reported have been compared with those of thirty simple cancer cases. This comparison was also made, eliminating cases with hemorrhage in both groups. In another paragraph the metachronous cases were excluded comparing only the synchronous cases of the two groups. In the metachronous cases the first cancer is often removed long before the second one appears. Consequently in such instances there cannot be any influence of a *multiple* cancer on

the blood, because there is only *one* cancer present at one time.

There are no remarks about the quality of the red blood corpuscles in the records, so these cannot be reported. The white corpuscles will not be discussed, although detailed remarks are available, because the cancer itself seems not to have any great influence on it. The hemoglobin average of multiple synchronous cancer shows small differences, which may be entirely related to normal fluctuation. The normal average hemoglobin per cent in metachronous cases, after eliminating the first cancer, may be reached. The impression is given that the quantity of the red blood cells has been reduced by multiple cancers more than by simple cancers. If this is correct, that may be due to the natural influence of the multiple cancer on the blood, which must be greater than that of the simple cancer cases.

To decide whether it would be possible to use a stronger reduction of the hemoglobin percentage and of the number of red blood cells as an added test in cases of suspicious multiple cancer, one would need quite a large number of multiple cancers.

CLINICAL VALUE OF THE PHOSPHATASE DETERMINATION IN THE BLOOD IN MULTIPLE CANCERS

One other possible laboratory approach is through the study of phosphatase in the blood. The question of the value of phosphatase determination, however, in these cases is not clear at this time. Lubinstein²¹ thinks that the phosphatase is valuable. Gutman,^{21a} on the other hand, believes the value of phosphatase is small until metastases appear either in the bones or the liver. Our experiences seem to suggest the advisability of making this test regularly in such cases. Perhaps it would be worth while to compare the results of other biochemical findings in multiple cancers with those of simple cancer cases. There are at present few reports of that nature in the literature.

DIAGNOSIS OF MULTIPLE CANCERS WITH
PARTICULAR REFERENCE TO X-RAY
EXAMINATION

We have twenty-one *synchronous* cases of multiple cancers. In eight of those cases the second cancer was an accidental finding. In one series of thirteen cases the correct diagnosis was made in four instances during life:

CASE I. Five days after a cecostomy for ileus the barium enema examination disclosed two cancers, one at the splenic flexure, and a second one in the descending colon (Fig. 1A and B). Eleven days later the diagnosis was confirmed when a colostomy was done. The proctoscopic examination was negative.

CASE II. This patient had cancers of the right breast and of the rectum. The latter was detected by barium enema and x-ray although the proctoscopic examination failed to disclose it.

CASE III. This involved two cancers of the right breast demonstrated by biopsy.

CASE IV. A carcinosarcoma of the left ovary was disclosed by laparotomy and biopsy.

In six of these synchronous cases of multiple cancers only one or two of the multiple cancers were diagnosed during life. Undiagnosed were: (1) A duodenal cancer shown at autopsy. Here the proctoscopy and the barium enema had shown a sigmoid cancer (Fig. 2A and B), and the operation (colostomy and resection) had demonstrated the cancer of the colon transversum. (2) A sigmoid cancer. Here the laparotomy had shown a cancer of the bile duct. An x-ray examination of the sigmoid (barium enema) was not done. The gastrointestinal series showed stomach and small intestines not changed. (3, 4 and 5) A cancer of the stomach in the three cases. X-ray examinations of the stomach were not done. (6) A cancer of the pancreas. Two x-ray examinations led to the erroneous conclusion of an ulcer simplex duodeni. The simultaneous cancer of the rectum was diagnosed by proctoscopy with biopsy. Metastases of cancer in the liver were recognized by an explorative laparotomy with biopsy. They were thought to be

derived from the cancer of the rectum, but the later microscopic examination showed them to be of pancreatic origin.

In three of these cases the multiple cancers were not diagnosed during life at all: (1) A cancer of the bile duct and a cancer of the ovary. An x-ray examination of the colon and one of the gallbladder were negative. A biopsy of the ligamentum suspensorium in an exploratory laparotomy established only a cancer of unknown origin with a number of peritoneal metastases. (2) A cancer of the bronchus and a cancer of the urinary bladder. A bronchoscopy and four x-ray examinations of the lung did not lead to a positive result. A cystoscopy was not done. Besides other vesical symptoms, hemorrhages of the urinary bladder were also seen. (3) A cancer of the stomach and two cancers of the lung, among them a small primary oat-cell cancer and a large secondary cancer of the lung of unknown origin. An x-ray examination without result was done in this case. An x-ray examination of the stomach was not done.

These cases have shown the importance of an exact clinical diagnosis. Examinations were made by x-rays, biopsy, and the use of bronchoscopes, esophagoscopes, gastrosopes, etc. Where complete x-ray examinations of the entire gastrointestinal tract were *not* made, some cancers were overlooked. Four cancers of the stomach, of which three were large ones, and a great cancer of the duodenum were not recognized. In all these four cases no x-ray examination was done. It seems clear that an x-ray examination of the *entire* digestive tract should be done in all dubious cases.

A critical review of the diagnosis of the *metachronous* multiple cancers leads to the following results: In eight metachronous cases the diagnosis of the first cancer has been made eight times by microscopic examination. A ninth case will be discussed at the end of this section. In five of the eight cases mentioned *the diagnosis of the second, i.e., metachronous cancer has been made during life*: (1) A sigmoid cancer by

x-ray, by resection of the sigmoid, and by biopsy; (2) a cancer of the uterus by biopsy of the uterus; (3) a bronchus cancer

the night because of an ileus. An x-ray examination postoperatively was without diagnostic results. (3) A cancer of the



FIG. 4. A, shows no evidence of cancer of esophagus; B, shows an extensive carcinoma of the middle third of the esophagus.

by bronchoscopy (with doubtful result), by biopsy of an expectorated piece of tissue and by seven x-ray examinations, of which three were positive. In this case because of the peculiar x-ray finding Dr. Ross Golden made the diagnosis of a primary cancer of the bronchus. (Fig. 3.) (4) A cancer of the esophagus by a positive esophagoscopy and three x-ray examinations, twice with a positive result. (Fig. 4A and B.) (5) A cancer of the bronchus by x-ray examination of the lung. However, this finding was interpreted during the life as a metastasis of the cancer of the splenic flexure, which was removed years before.

Three times in the above mentioned eight cases the diagnosis of the metachronous cancer was not made during life: (1) A large cancer of the urinary bladder (7.5 by 1 cm.). Neither symptoms nor metastases appeared. (2) A cancer of the colon ascendens. Sixteen years after the resection of the cecum because of an adenocarcinoma a colostomy had to be done suddenly during

cecum. Twenty months after the diagnosis and after the operation of two synchronous cancers of the colon, autopsy uncovered a great, annular, obturating crater in the cecum, in the middle of which a large polyp was prominent. An irregular, intraperitoneal abscess cavity communicated with the lumen of the cecum. An x-ray examination had been made seven months before death. The possibility of a new primary cancer was considered, but the diagnosis of "regional ileitis" was made, because it was thought not likely that a third primary cancer would have originated in the colon. (Fig. 5.)

In this relation the following data are instructive: In thirty multiple cancer cases we had three cases with three or more multiple colon cancers:

Case No.	No. of Cancers
1	3 Colon
9	3 Colon
30	4 Colon, 1 Rectum

We have thus in 10 per cent of the multiple cancers three simultaneous colon can-

cers. It is therefore not unlikely, after having had two colon cancers, that a third primary colon cancer is present and it is

one of the cases (Fig. 5A, B, C) reminded one very much of an obturating cancer of the cecum, but it is doubtful if an opera-

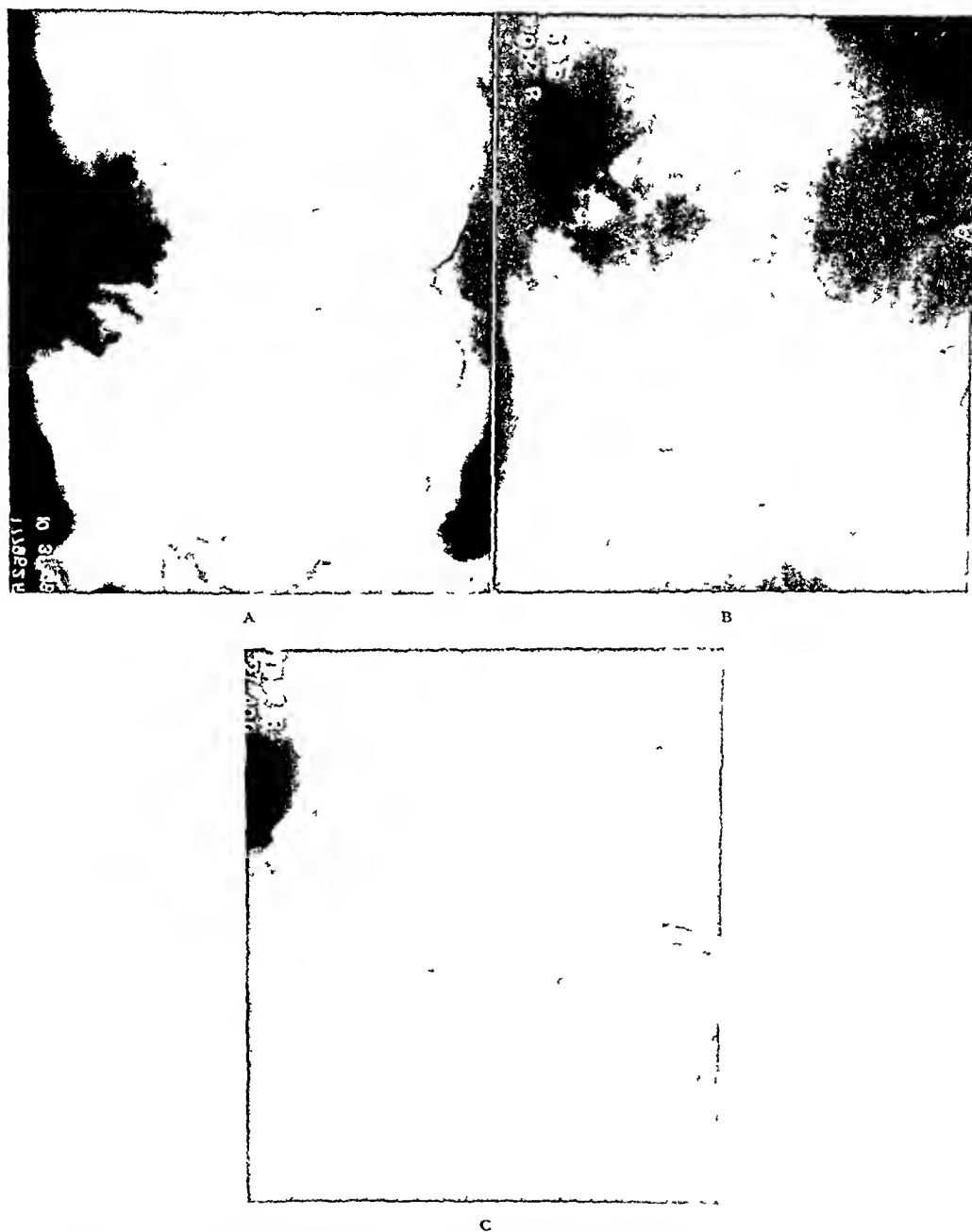


FIG. 5. A, shows a complete obstruction to the retrograde flow of barium suspension at the *splenic flexure*. The growth known to be in the *rectum* is hidden by the barium suspension which distends and fills this region. B, shows a large irregular defect in the contour of the cecum and terminal portion of the ileum. C, shows the defect in the cecum to persist by the barium suspension, which distends and fills this region.

absolutely correct to consider this possibility if the symptoms agree with it. Retrospectively, the picture of the x-ray in

tion half a year before death would have been successful, because the metastases of this tumor in the retroperitoneal lymph

gland, liver and lung shown in autopsy were very extensive.

This case, therefore, is very instructive,



FIG. 6. Shows a constriction of the pyloric antrum and a large crater on the greater curvature site. The x-ray appearance is not suggestive of a malignant lesion, but of multiple ulcers. At autopsy this was proved to be a carcinoma.

because the first two cancers of the intestine were established by x-ray examination, the rectum cancer by barium enema, the cancer of the splenic flexure by a gastro-intestinal series, and because two successful large operations of the intestine were performed.

A case between the synchronous and the pure metachronous will now be discussed. In the beginning of the disease the diagnosis of the first cancer (pyloric cancer) was *not* made. After three x-ray examinations, (Fig. 6) the opinion was that an ulcer duodeni was present, and a gastro-enterostomy was performed. A year later, a barium enema was given, but because of spasms only a poor x-ray resulted. Because of the other clinical symptoms, the diagnosis of a cancer of the sigmoid

and a cancer of the stomach or the ovary with metastases was made. The autopsy showed an annular, obturating adenocarcinoma of the sigmoid and an obstructing cancer of the pylorus.

Investigation of the metachronous multiple cancer cases shows that the x-ray examination had been applied very extensively, (for instance, in one case *seven* times in all). The x-ray examinations gave *five positive results in seven cases* of metachronous cancers. The reason for the careful and repeated x-ray examination was probably the fact that a certain cancer had already been diagnosed.

IMMUNITY IN MULTIPLE CARCINOMA

Boyd²² maintains the view that the presence of one carcinoma affords immunity against the development of a second one. He says: (1) Acquired immunity to cancer (artificially produced) is common in mice. When a cancer, either produced by tarring or occurring spontaneously, is removed and the mouse tarred again, no tumor will develop. The presence of one tumor usually confers an immunity which prevents another from developing. (2) For this reason multiple malignant growths are remarkably rare. (3) Cancer of the rectum and to a much lesser degree of the large bowel is often preceded by the development of a papilloma or adenoma. These papillomas may be multiple but when one of them becomes malignant, the others tend to disappear so that at the autopsy, none may be observed. The change is best seen in surgical specimens removed at an early stage. (4) Multiple papillomas in adenomatous polyps may recur in any part of the intestinal canal . . . they have a strong tendency to become malignant. The carcinomatous change occurs only in one papilloma.

It seems to be true that multiple carcinoma is of exceptional occurrence. In thirty-six years of clinical practice, I have seen but one case, a carcinoma of the uterus, which I removed, and three and one-half years later, an early carcinoma

of the breast.²³ Among the thirty cases here reported, there was only one uterine cancer. In the literature, up to 1935, there were but three recorded cases of uterine and breast cancer. Generally speaking, however, multiple carcinomas are *not* "remarkably rare," as Boyd alleges, since in the Presbyterian Hospital autopsy records, 5 per cent of all cancers were multiple. With increasing histological experience and thoroughness, the percentage would probably be even higher.

Nor is there complete agreement with Boyd's remarks about immunity in multiple cancer of the digestive tract. Four of our cases are not in accord with his statements.

In one case a carcinoma of the colon had been removed by resection and another of the sigmoid by proctectomy. A year later, a third carcinoma arising in a polyp, was found at autopsy in the cecum, and two additional carcinomatous polyps in the colon ascendens.

In a second case a carcinoma of the cecum with papillary growths was resected. Sixteen years later, following an urgent colostomy, a second primary carcinoma of the colon and a beginning carcinoma in a jejunal polyp were disclosed at autopsy.

In a third case a carcinoma of the appendix was removed. Three and one-half years after the operation, a cecostomy and resection of the sigmoid were performed. The surgical specimen contained a cancerous polyp of the sigmoid and three other polyps; and at the autopsy, ten days later, numerous polyps of the colon and sigmoid were found.

In a fourth case a carcinomatous polyp of the transverse colon was removed by excision; eleven days later a portion of the colon was resected, and this contained 120 polyps. At autopsy, nineteen days after the first operation, there were found: (1) A duodenal cancer with a papillary structure suggesting a polyp origin; (2) a carcinoma of the sigmoid, very suggestive of a polypoid structure; (3) a carcinomatous polyp of the jejunum, and (4)

numerous polyps in the small intestine, over a distance of 50 cm. distal to the duodenal cancer, and also in the colon and lower segment of the sigmoid.

Two cases with polypoid cancers, three of which definitely had originated in polyps, show that the development of multiple primary cancer, contrary to the statement of Boyd, is not prohibited by the appearance of malignant changes in a single polyp.

PROGNOSIS

Of thirteen clinical cases of multiple cancers during 1923 to 1940 in the Presbyterian Hospital five patients are living. The five cases are the following:

CASE I. The patient, sixty-two years of age, with multiple cancer (metachronous) had a (biopsy of larynx) performed on September 23, 1937, and a squamous cell epithelioma of the larynx was diagnosed. It was too far advanced for laryngofissure; it was well differentiated and had not invaded the underlying tissue to any great extent. Total laryngectomy "seems to have been completely removed." On March 30, 1939, an alveolar adenocarcinoma of the prostate was found and transurethral resection of the prostate was performed. There was no evidence of recurrence on January 4, 1941.

CASE II. This patient, forty years of age, had multiple cancer (metachronous). It was typically adenocarcinoma of the transverse colon in the hepatic flexure; there was a hard mass which was not adherent; there were no metastases in a lymph gland or anywhere else. Operation on November 23, 1923, consisted of partial colectomy, resection of ascending cecum and part of the transverse colon and ileocolostomy. A fairly well differentiated adenocarcinoma of the rectum penetrated the muscle layer and perirectal fat but there was no blood vessel invasion. A biopsy performed on November 28, 1939, was somewhat similar to the previous one but was more differentiated. There were no metastases in forty-six lymph glands. On December 4, 1939, abdominoperineal resection was performed and the prognosis was relatively good. On May 28, 1941, the wound had healed, the colostomy was working well and the patient had no complaints.

CASE III. The patient, thirty-seven years of age, had multiple cancer which was metachronous. She had carcinoma of the left breast with metastases to the axillary lymph-nodes. X-ray radiation was used and on April 26, 1933, radical mastectomy performed. Small lymph-nodes in the axilla had been invaded. No radiotherapy was used postoperatively. There was a fairly well differentiated group of tumor cells with metastases to two small lymph-nodes. Papillary adenocarcinoma of both ovaries developed and on March 3, 1939, supravaginal hysterectomy and bilateral salpingo-oophorectomy were performed. On April 25, 1941, the patient weighed 144 pounds and there were no metastases.

CASE IV. The patient, a sixty-nine year old woman, had multiple cancer of the synchronous type. On February 23, 1939, she had a basal cell carcinoma of the skin of the forehead the base of which was covered with a reddish brown, dark, superficial crust. The borders were markedly raised and poorly infiltrated. She gave a history of having been hit by a nail. The pathological report was missing. X-ray treatment had been given. On March 22, 1939, adenocarcinoma of the rectum was diagnosed. There was an annual constriction of the rectum, 8 cm. long, the borders of which were knobby, hard, tender and irregular. A finger could not be inserted through the opening. This was a moderately well differentiated tumor which had not metastasized to any of the thirty-six lymph glands found. The prognosis was good. Operation consisted of abdominoperineal resection of the rectum and sigmoid colostomy. On May 13, 1941, the patient had gained weight and there were no evidences of metastases.

CASE V. The patient, a forty-seven year old woman, had synchronous multiple cancer. She had a multilocular papillary serous cysto-adenocarcinoma of both ovaries. On March 11, 1938, supravaginal hysterectomy and bilateral salpingo-oophorectomy were performed. In the area of the right ovary a large fungating mass perforated the former ovarian capsule in several places and this condition existed in the area of the left ovary also. There was no ovarian tissue present. On June 20, 1941, no bleeding, discharge or pain were present. The patient weighed 154 pounds and the pelvis was clear.

Of the three metachronous cases which are living, the interval in Case I between

the first cancer and July 1, 1941, is four years, between the second cancer and July 1, 1941 is two and one-fourth years; in Case II between the first cancer and July 1, 1941 the interval is seventeen and one-half years, between the second cancer and July 1, 1941, the interval is one and one-half years; in Case III between the first cancer and July 1, 1941, there is an interval of eight and one-fourth years, and between the second cancer and July 1, 1941, there are two and one-fourth years.

All these three cancer cases cannot be described as perfectly healed, because they have not reached the five-year term, but it is very interesting to see that in Case III, with eight and one-fourth years and Case II, with seventeen and one-half years, the first cancer can be said to be absolutely healed postoperatively. There is also the hope for healing of the second cancers. Also, in the two synchronous cases, Case IV with three and one-fourth years after operation and Case V with three and one-fourth years after operation, both patients are still in good health, but the five-year limit has not been reached. However, there is good reason to believe that all the five patients will be absolutely cured. Therefore, the prognosis in multiple cancer treatment is not altogether hopeless.

SUMMARY

1. A clinical analysis of thirty cases of multiple cancers has brought out the fact that the period from the first appearance of symptoms until death was shorter in cases of multiple primary malignant growths than in single ones; the weight loss was also considerably greater.

2. The correct diagnosis of multiple cancer was made during life in four of the synchronous and in five of the metachronous cases. It shows very clearly how much the diagnosis of cancer owes to radioscopy. X-ray examinations of the total digestive tract, not only of its segments, should be carried on, because of the high percentage of multiple cancers in different segments of the digestive tract.

3. The influence of multiple cancer on the blood as well as the study of the value of the phosphatase reactions in multiple cancer should be further investigated.

4. The view expressed by Boyd "that the present of one malignant tumor usually confers an immunity which prevents another from developing" and that the "carcinomatous changes in multiple polyps of the intestine occurs only in one papilloma" is not borne out by this material. In four cases of polyposis, there were multiple cancers of the large intestine; in one instance, there were three primary growths and in another five.

5. Thirteen clinically observed cases of multiple cancer were studied, of which five are living and eight are dead. Among the living cases we had two synchronous and three metachronous cases. The two synchronous cases were two and one-half years and three and one-fourth years after operation. Both are still in good health, but the five-year limit has not been reached. Also, the three metachronous cases have not reached the five-year limit. There is good reason, however, to believe that all five patients will be absolutely cured. Therefore, it can be concluded that the prognosis in multiple cancer is not altogether hopeless.

I wish to express my indebtedness to Dr. A. M. Pappenheimer and Dr. George Draper for valuable suggestions.

I also wish to express my thanks to Dr. R. Golden for his permission to publish the x-ray

pictures from the Department of Radiology, to Dr. P. C. Swenson, and especially to Dr. L. M. Pascucci for their collaboration in interpreting the x-rays.

REFERENCES

1. WARREN, SHIELD and GATES, OLIVE. *Am. J. Cancer*, 16: 1902, 1932.
2. ANDERHUB, H. *Über Multiplicität primärer bösartiger Geschwülste*. Zürich, 1937.
3. COKKINIS, A. J. *Brit. J. Surg.*, 21: 571, 1933.
4. BACON, H. E. *Am. J. Cancer*, vol. 35, 1939.
5. HURT, H. H. and BRODERS, A. C. *J. Lab. & Clin. Med.*, 18: 765-777, 1933.
6. HARBITZ, F. *Zieglers Beiträge f. path. Anat.*, 62: 561, 1916.
7. RÖSSLE, R. *Multiple Tumoren und ihre Bedeutung für die Frage der Konstitutionellen Entstehungsbedingungen der Geschwülste*. *Ztschr. f. ang. Anat.*, 5: 126, 1919.
8. SIEBKE, H. *Ztschr. f. Krebsforsch.*, 23: 66, 1926.
9. BARTEL. *Cit.*⁸
10. EGLI, F. *Korresp. Blatt f. Schweizer Ärzte*, 44: 449, 1914.
11. SWIELINSKI. *Cit.*⁸
12. BUGHER, J. C. *Am. J. Cancer*, 21: 809, 1934.
13. WELLER, C. V. *Am. J. Cancer*, vol. 30, 1937.
14. CUSHING, H. *Meningioma*. p. 17, 100-101, 1938, Thomas.
15. DAVIDSON. See Stout.²⁰
16. GENKIN and DIMSTRUCK. See Stout.²⁰
17. MURRAY, WOGLOM, CRAMER. a. See Boyd, W. P. 287; b. *Arch. Path.*, 2: 533, 1926; c. *Am. J. Med.*, 181: 157, 1931.
18. EWING, JAMES. *Neoplastic Diseases*. 1928, p. 68; 1930, p. 51. Philadelphia, Saunders.
19. WOGLOM, W. H. *Studies of Experimental Cancer*. 1913, Vol. 1, p. 92. Columbia University Press.
20. STOUT, A. P. *Human Cancer*. 1932. Lea & Febiger.
21. LUBINSTEIN, H. *Ztschr. f. d. ges. exper. Med.*, 37: 456, 464, 465, 1936.
- 21a. GUTMAN, A. B. *Arch. Int. Med.*, 57: 379, 1936.
22. BOYD, WILLIAM. *Text Book of Pathology*. Lea & Febiger. III Edition, 1938, p. 296, 558, 559.
23. HELLENDALL, HUGO. *Centralbl. f. Gynäk.*, vol. 43, 1935; vol. 28, 1937.



TUMORS IN THE REGION OF THE CAUDA EQUINA

A REVIEW OF TWENTY-FIVE CASES

IRA COHEN, M.D.
Attending Neurological Surgeon,
Mt. Sinai and Montefiore Hospitals
NEW YORK, NEW YORK

AND

LIEUT. COMDR. ABRAHAM KAPLAN, M.C.
United States Naval Hospital
PORTSMOUTH, VIRGINIA

TO a great many the differential diagnosis of low back pain with or without sciatic radiation is a daily and a very important problem. The problem calls for a systematic investigation of the many causes of the "so-called sciatic syndrome." Among these causes, particularly since the publications of Mixter and Barr,¹ the herniation of an intervertebral disc and hypertrophied ligamentum flavum has gained such prominence that other causes of sciatic pain are being pushed to the background and are failing to receive the attention they deserve. Among these less frequent, but equally important causes responsible for back pain with sciatic radiation are tumors of the cauda equina.

Our recent experiences have shown that the presenting symptoms in early cases of tumors of the cauda equina are not unlike those elicited in patients with herniated nucleus pulposis. Because of this great similarity a review of those tumors was undertaken to learn if there are any dependable criteria of differentiation. From a therapeutic point of view it is very important to distinguish between these two conditions, especially since the operative exposure of a disc is as a rule a very limited one, and a neoplasm of the cauda equina through such an exposure can readily be overlooked.

As was recently pointed out by Van Wagenen and Rossier² the early diagnosis of spinal cord tumors is still not too frequent. In their study of thirty-three cases of spinal cord tumors only three patients were ambulatory at the time of admission. On the average seventeen months elapsed from the time the patient first consulted a physician until the time of operation.

Even more difficult is the early diagnosis of neoplasms in the region of the cauda equina. Among the helpful diagnostic criteria with reference to early recognition of such lesions Bennett³ has stressed spasm of the erector spinae muscles, shortening of the hamstrings, and pain upon hyperextension of the spine and extreme flexion of the legs. It is interesting that such were the early findings in Bagley's⁴ unusual case of a dermoid of the cauda equina.

In Allen's⁵ review of sixty-nine cases of cauda equina tumors from the National Hospital Queen's Square the first and most constant symptom was intermittent back pain with remissions varying from several months to a year. This was present in 90 per cent of the cases. Coughing, straining, or lying in the recumbent position aggravated the pain. In about 60 per cent of the cases motor disability followed sensory disturbances, and yet in 23 per cent of the entire group sensory changes were absent. The first abnormal tendon reflex changes were found in the ankle jerks. However, it is significant that in 10 per cent of the cases all reflexes were entirely normal. Spurling and Mayfield⁶ found that the absence or diminution of the tendon reflexes of the lower extremities were among the earliest objective neurological findings in cauda equina neoplasms.

Inflammatory lesions of the cauda equina may easily mimic the findings of a neoplasm in this region. From a surgical point of view it is more important to determine the presence or absence of a growth in the region of the cauda equina, rather than its exact location. Elsberg and Constable⁷ in a study of forty-five cases, twenty-eight of which proved to have a new growth,

found that the total protein of the spinal fluid was the most helpful diagnostic factor. In each instance in which a neoplasm was found the total protein was increased, whereas in those instances with inflammatory lesions there was no elevation of the total protein.

ANALYSIS OF CASES

This group of twenty-five patients with tumors of the cauda equina represents 18.5 per cent of the total number of spinal cord tumors in our series. While analyzing this series of cases it became quite evident that in the very early stages neoplasms in this region are unusually difficult to recognize and at times practically impossible to differentiate from a herniated intervertebral disc. On the other hand in the very advanced stages the diagnosis of a cauda equina tumor can often be made at a glance.

As the clinical syndrome, which these neoplasms produce, becomes more familiar, precise diagnostic studies of the spinal fluid will be employed earlier and more frequently. The results of such studies will inevitably lead to earlier recognition of neoplasms of the cauda equina, and treatment will be instituted long before irreversible damage to the roots has taken place.

The clinical picture of the twenty-five patients under consideration can best be appreciated if they are grouped under the following three headings:

1. Cauda Equina neoplasms with advanced neurological signs. In other words those who entered the Hospital not on their own motor power. Of these there were five patients, 20 per cent of the cases.

2. Cauda Equina neoplasms with early neurological signs. Those who at the time of admission were still able to walk with little or no assistance. These numbered sixteen patients in our series or 64 per cent of the cases.

3. Cauda Equina neoplasms with no objective neurological signs. These patients, four in number, (16 per cent) were

recognized as a result of systematic laboratory studies. More specifically, the abnormal spinal fluid findings and the injection of lipiodol clearly established the presence and position of the new growth.

In our first group of five patients who were unable to enter the hospital on their own motor power, two patients had malignant neoplasms. One was an osteogenic sarcoma and the other a neuroblastoma.

The remaining three patients had benign neoplasms, two neurofibromas and one ependymoma.

The outstanding and initial symptoms in these patients was pain over the lumbosacral region. The duration of pain varied on the average from six months to one and one-half years, but in one patient the pain had persisted for almost thirty years. The pain in all these patients radiated from the lower back down one leg and then spread to include the other and was consistently accompanied by weakness of either or both legs. Urinary symptoms presented themselves from two weeks to four months before hospitalization.

Atrophy of the legs accompanied the paresis and sensory loss was confined to the sacral segments. The knee and ankle jerks were either seriously diminished, or completely absent. Urinary retention with overflow of the bladder was the rule.

In only one instance was there widening of the lumbar canal by x-ray. In another case there was x-ray evidence of destruction of the body of the third lumbar vertebra due to invasion by malignant growth.

Lumbar puncture in two cases showed xanthochromic fluid and complete manometric block. In two patients it was necessary to inject lipiodol for the exact location of the neoplasm.

There were no operative fatalities and improvement was noted only in the three patients who had benign neoplasms. With return of power there was return of urinary control and then a better appreciation of sensation. These three patients left the hospital greatly improved and now are able to care for themselves.

An example of this group is the following case history:

On January 6, 1936, a fifty-six year old housewife was admitted to the hospital because



FIG. 1. Lipiodol arrest at lower border of thoracic 12. Note irregular shape of "cap" outlining upper pole of neoplasm.

she was no longer able to walk. The patient was in a good state of health until six months previously, when she began to have pains across the lower back. Shortly after the onset of the back pain she also noted pain in both hips, and then pain in both knees radiating down the anterior aspect of both legs to the toes. These pains were sharp and intermittent and were not influenced by coughing or straining. About this time there was also weakness noted of both legs and increasing difficulty in walking. Soon there was delay in starting urination, then urinary retention and finally overflow incontinence. For two weeks before admission these symptoms advanced rapidly so that she was no longer able to get out of bed.

Examination showed a thin, emaciated, and chronically ill person with marked wasting of the muscles of the lower extremities, and a decubitus on the left heel and over the sacrum.

There was some movement of the toes, otherwise the legs showed a flaccid paralysis. Sensation of pain, temperature and light touch was completely lost on both sides over skin areas of sacral two to five inclusive. In addition



FIG. 2. Patient's position while standing.

there was hypesthesia over the first sacral areas. Position and vibration sense were not impaired. Knee jerks, ankle jerks and lower abdominal reflexes were absent.

Lumbar puncture failed to yield any fluid. Lipiodol was then injected through the cisterna magna and came to a complete arrest at the twelfth thoracic vertebra. (Fig. 1.)

Laminectomy disclosed a well encapsulated intra-arachnoid tumor extending from the conus to the fourth lumbar vertebra. The tumor was bluish red, vascular and friable. It filled the entire canal and was intimately attached to the roots of the cauda equina. An intracapsular removal of the tumor was done.

The postoperative course was stormy, difficult and at times very discouraging. For over a fortnight there was a septic type of fever rising to 103°F. due to a persistent cystitis and pyelonephritis. In addition there were further

complications of a decubitus over the right trochanter and over the sacrum.

Because the neoplasm showed some suspicious areas of malignancy, the patient was given a series of x-ray treatments. Soon the pain disappeared and her general condition began to improve. There was also slight evidence of returning sensation and at the end of two months the left leg began to move.

Six months after the operation she was transferred to Montefiore Hospital where improvement continued. After two years she was finally discharged sufficiently well to walk without assistance and with no sphincter disturbance.

Re-study of the tumor proved it to be one of the benign types of spinal cord neoplasms: an ependymoma.

Comment. It is well to note that for six months this patient's condition was not recognized. By this time she was almost completely paralyzed, had urinary retention and decubitus; indeed she was a very poor surgical risk. Fortunately, the tumor proved to be benign. Two years of hard work by several departments put this patient on her feet. Had the diagnosis been made earlier, the patient would have been in far better condition for operation, the removal of the tumor would have been much simpler, and the recovery more rapid.

In group two there were sixteen patients with early neurological signs who at the time of admission were still able to walk.

A composite of their histories and findings is as follows: Four of these patients had a definite history of trauma shortly before the onset of the symptoms. The pain radiated down one leg in three cases but the radiation was bilateral in thirteen cases. In twelve cases the pain was aggravated by coughing, sneezing or straining. Sensory complaints of coldness, numbness, or tingling were referred to one extremity in three cases and bilaterally in four cases. One patient noted progressive weakness in one leg, but five observed this symptom in both legs. Sphincteric disturbances of the urinary bladder varied in onset from two days to four months before admission in six patients. Of these, five stated they had

difficulty in initiating urination; only one had urinary retention.

Motor weakness of one leg was found in seven cases, and paresis of both legs was found in five cases. Sensory defects were chiefly hypalgesia and hypesthesia, involving the sacral segments. Anesthesia over these regions was unusual. In ten cases the sensory abnormality was bilateral in distribution and in three cases it was unilateral. Abnormal reflexes of the lower extremities were not consistently present. For example, knee jerks were diminished or absent on both sides in five cases, and on one side in three cases. The ankle jerks were diminished or absent bilaterally in ten cases and unilateral in four cases. Lasègue sign was present only in two patients. In one it was bilateral and in the other patient it was only on one side. The abdominal responses were impaired bilaterally in two cases and unilaterally in two cases. Spinal tenderness over the lumbosacral region was found in seven of the sixteen patients. X-ray studies of the spine in this group yielded no helpful data.

The spinal fluid studies on the other hand were very helpful in establishing the diagnosis. In twelve patients the fluid was xanthochromic and of these five showed a Froin syndrome. Eight patients showed complete manometric block. In only two patients was the total protein of the spinal fluid within normal limits, in eight others it was markedly increased. One patient showed a total protein of 1,920 mg. per cent.

Laminectomy was performed in this group of patients without operative mortality.

In three of the sixteen patients malignant infiltrating tumors were found and removal was necessarily incomplete. Of the remaining thirteen patients seven had neurofibromas, three ependymomas, two meningiomas and one a benign cyst.

As an example of this group the following may be briefly cited:

On Sept. 10, 1935, an eighteen year old girl was admitted to the hospital because of in-

creasing difficulty in walking. She was in very good health until two years before admission, when she began to have pain in the

she could walk only on her toes and was unable to stand on her heels. (Fig. 2.) In addition there were adductor spasms of both legs.

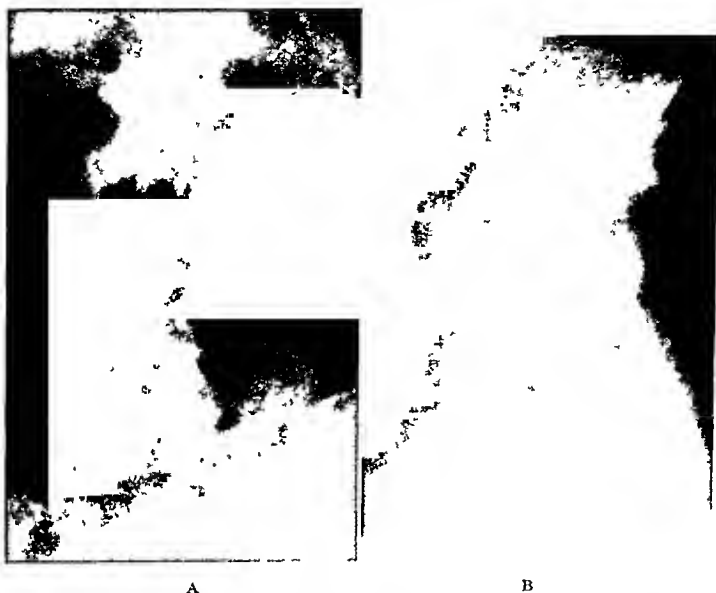


FIG. 3. Typical "cap" deformity of arrested lipiodol at third lumbar vertebra.

right thigh, which radiated down the right leg to the ankle. A year later the right leg became stiff and after three months pain and stiffness

Hypalgesia was found to affect skin areas of sacral 3 to sacral 5 on the left, and sacral 4 and 5 on the right. Light touch and temperature were less affected over this area. Both knee jerks were absent; the right ankle jerk was sluggish and the one on the left failed to respond.

The spinal fluid was clear and colorless, showing only two cells, and no block to jugular compression. Wassermann test was negative and total protein was only 27 mg. per cent. In spite of these findings lipiodol was injected. This came to a complete arrest at the third lumbar vertebra. (Fig. 3.)

Laminectomy was performed from lumbar 3 to sacral 1 inclusive. The exposed dura was blue and tense. When the dura was opened a tumor was found filling the entire canal hiding all the roots of the cauda equina. Fortunately, this neoplasm was fairly well demarked and, except for a few tabs adherent to some roots, it was completely removed. (Fig. 4.) Microscopic study of this tumor was subsequently reported ependymoma.

The postoperative course was uneventful, except for some urinary retention which cleared up within some days. It is now over six years since the operation; the patient has remained well able to go to business and shows no abnormal findings.



FIG. 4. Showing size of well demarked tumor.

spread to the left leg. Forward bending was limited to about 15 degrees. About this time she also noted coldness and numbness in both legs. Coughing, sneezing or straining caused a tingling and tightening sensation in both lower extremities. For several months she noted that during the night both legs would suddenly jump up. The menses were irregular, but there were no urinary symptoms.

General physical examination was normal. Neurological examination showed the following abnormalities: Spasticity of both legs so that

Comment. For fifteen months this patient had typical "sciatic" pains radiating down the right leg and then it spread to the other leg. With very rare exceptions, bilateral "sciatica" is due to a growth in the region of the cauda equina. The gait and the adductor spasms were so typical of a cauda equina tumor that in spite of negative spinal fluid studies, lipiodol was injected for exact localization. The removal of this benign growth was much easier than in the previous case and recovery was more gratifying.

In our last group in which cauda equina neoplasms produced no abnormal neurological signs there were only four patients.

It is in these patients that a carefully taken history will lead to the correct diagnosis, for in this group one must depend on symptoms rather than on signs. Pain across the lower back at first radiating down one leg and then down the other was the most constant complaint. The duration of the pain varied from seven weeks to two years and was aggravated in each patient by coughing, sneezing or straining. In two patients the pain was worse in the prone position, and they found relief from pain only when in the erect posture. Periods of remission from pain were present in all the patients and in one case it lasted eighteen months.

Repeated neurological examinations failed to disclose any abnormal findings. X-ray studies of the lumbosacral region were normal. Nevertheless it should be remembered that there are many diseases of the spine which begin by involving the osseous structures before producing nerve irritation and compression. These, therefore, must be excluded by careful roentgen ray studies.

The information gained from lumbar puncture and spinal fluid findings were of greatest value in establishing the correct diagnosis. Since lumbar puncture is such a simple, safe and informative laboratory procedure, it is difficult to understand why there should be any hesitation about doing it. Without careful examination of

the spinal fluid the study of a patient with low back pain is incomplete.

All the patients in this group, four in



FIG. 5. "Cap" deformity at upper border of fourth lumbar vertebra. Note the lipiodol at lower end of dural sac (sacral 1) showing block was not complete.

number, showed xanthochromic spinal fluid and in two of these there was a Froin syndrome. The total protein of the spinal fluid was 100, 86.5, 150 and 338 mg. per cent, respectively. Lipiodol injection in three patients showed an arrest of the opaque oil and clearly demonstrated the upper position of the growth. In the fourth case operation was performed without lipiodol studies.

Briefly an example of this group is as follows:

An obese Italian housewife, aged thirty-four, was admitted on February 21, 1941, because of pain down the right leg of three years' duration. Fifteen years and again six years before admission the patient skidded down a flight of stairs striking the lower spine without any immediate ill effects. Three years before admis-

sion she began to experience spasmodic "pulling" pains in the right gluteal region which were aggravated by changes in position. X-ray



FIG. 6. Neurofibroma (Schwannoma) removed from fifth lumbar root.

films of the spine at this time revealed considerable arthritis. She was given injections of vaccine therapy into the sciatic nerve and after several months there was marked improvement. Eighteen months later there was an exacerbation of the pain which now began to radiate down the right thigh. X-ray of the lower spine at this time showed "spinal curvature and arthritis." Injections into the sciatic nerve were repeated but were ineffective. One year before admission the pain became so severe, that she had to discontinue her household work. Bending, coughing or lying down greatly intensified the pain. There were no urinary, rectal or menstrual disturbances.

The patient was unusually obese, and x-ray films of the gallbladder showed three calculi; otherwise the general examination was negative. Any extension of the legs caused a severe exacerbation of pain. The patient preferred to sleep in the sitting position. Repeated neurological examinations failed to show any abnormality.

Roentgen study of the spine showed productive spondylitis from the sixth to the ninth thoracic vertebrae, and also some arthritic changes in the lumbar segments, and in the sacro-iliac synchondrosis.

The spinal fluid was faintly xanthochromic and within a few minutes clotted spontane-

ously. The total protein was 338. mg. per cent. Lipiodol was injected and was arrested at the upper border of the fourth lumbar vertebra. (Fig. 5.)

Laminectomy disclosed an intradural tumor attached to the fifth lumbar root on the right. The growth was easily and completely removed and proved to be a neurofibroma. (Fig. 6.)

The postoperative course was uneventful and three weeks after operation she was discharged completely free of pain and to date is carrying on her household duties without any discomfort or difficulty.

Comment. In this patient the diagnosis of a cauda equina neoplasm was suspected from the symptoms. The laboratory findings confirmed these suspicions and the operation proved the diagnosis. The removal of the growth was comparatively simple and the resulting recovery prompt and complete.

SUMMARY

In reviewing our group of twenty-five cases as a whole, and keeping in mind the problem of the differential diagnosis of herniated nucleus pulposus, certain observations were made. Six patients had a history of trauma immediately preceding the onset of symptoms. There were, however, additional instances of long antecedent trauma, but these are not included. In some there was a fall and an injury to the back, while others stated that they felt something snap in the region of the lower spine during a sudden and unusual exertion. One can only speculate about the relationship of trauma which may cause a shift of the tumor to the immediate onset of symptoms. Even more difficult is an adequate explanation for the remission of symptoms which were noted in seven patients. The free interval varied from weeks to months. In six of these patients a soft type of tumor was found at operation, but in one of them the tumor was a hard neurofibroma.

The spinal fluid studies were of greatest help. In one patient in whom fluid could not be obtained a tumor completely filling

the lumbar canal was found at operation. In seventeen of the remaining twenty-four cases the spinal fluid was xanthochromic. The finding of xanthochromia in a protruded disc is so rare, that the question of a neoplasm should be raised immediately. Other details of the dynamics of the fluid have frequently been stressed. We have found multiple spinal punctures to be of considerable localizing value, so that some cases have been spared lipiodol injection.

The most frequent type of tumor was the neurofibroma, of which there were ten; there were four ependymomas, two meningiomas, two neuroblastomas and four miscellaneous growths.

While there was no operative mortality or death in the hospital, the patients with malignant tumors survived but a few months. The majority of the patients, even those with advanced signs at the time of admission, have done exceedingly well.

CONCLUSIONS

The early diagnosis of neoplasms in the region of the cauda equina can and should be made before the roots have suffered

serious damage. A history of intermittent "sciatic" pain which fails to respond to simple nonsurgical measures, should have the benefit of complete spinal fluid studies. If there is any doubt as to the exact location of the tumor, lipiodol injection is indicated.

REFERENCES

1. MIXTER, W. J. and BARR, J. S. Rupture of the intervertebral disc with involvement of the spinal canal. *New England J. Med.*, 211: 210, 1934.
2. VAN WAGENEN, W. P. and ROSSIER, J. Tardy diagnosis of tumors affecting spinal cord. *New York State J. Med.*, 38: 1169-1176, 1938.
3. BENNETT, G. E. Tumors of cauda equina and spinal cord; report of 4 cases in which marked spasm of erector spinae and hamstring muscles was outstanding sign. *J. A. M. A.*, 89: 1480-1483, 1927.
4. BAGLEY, C. J. Unusual symptomatology of cauda equina tumors. *Tr. Am. Neurol. Ass.*, 66: 171-175, 1940.
5. ALLEN, I. M. Tumors involving the cauda equina. A review of their clinical features and differential diagnosis. *J. Neurol. & Psychopath.*, 11: 111-143, 1930.
6. SPURLING, R. G. and MAYFIELD, F. H. Neoplasms of spinal cord; review of 42 surgical cases. *J. A. M. A.*, 107: 924-929, 1936.
7. ELSBERG, C. A. and CONSTABLE, K. Tumors of the cauda equina. The differential diagnosis between new growths and inflammatory lesions of the caudal roots. *Arch. Neurol. & Psychiat.*, 23: 79, 1930.



AN INTERNAL FIXATION DEVICE FOR THE TREATMENT OF INTERTROCHANTERIC FRACTURES OF THE FEMUR

HERBERT V.H. THATCHER, M.D.

On Staffs of St. Vincent's and Providence Hospitals

PORTLAND, OREGON

FOR the past year and a half, my associates and I have treated intertrochanteric fractures of the femur by means of an internal fixation device consisting of a modified Smith-Petersen nail and a wood screw. When assembled, the nail and the screw form a 90 degree angle support. This arrangement permits early weight bearing since the screw, by passing obliquely through the femoral shaft, holds the reduced comminuted fragments firmly in place. The technic of placing the nail and the screw is relatively simple. Furthermore, the time required for insertion of both the nail and the screw is little more than that which is necessary for insertion of the nail alone.

To date, we have treated thirteen patients by this method, three men and ten women. The results have been most encouraging. All but one of the patients were able to start weight bearing early. Displacement of bony fragments could in no instance be demonstrated. Morbidity was negligible and there was only one death. The patient who died was an eighty-five year old woman. Her death, about a month after operation, was due to bronchopneumonia.

DESCRIPTION OF NAIL AND SCREW

The twice modified, three-flanged Smith-Petersen nail we use (A, Fig. 1) is made of vitallium; and is manufactured in three lengths, 3, $3\frac{1}{4}$ and $3\frac{1}{2}$ inches. The first of its two modifications was devised by Johansson, and consists of a "central canal." Because of this canal, it is possible to slip the nail over a previously inserted guide wire when the nail is to be driven

through the upper end of the femur. The other modification was made by the author. It consists of a hole cast at right angles through the head of the nail. (B, Fig. 1.) This right angle hole serves a twofold purpose. The first is to guide the drilling of an oblique channel through the femoral shaft. (Fig. 2.) The second is to help stabilize the screw placed into this channel. (Fig. 3.) The diameter of the right angle hole is about $1\frac{3}{64}$ of an inch, or approximately the same as that of the unthreaded shank of the screw it receives. It is important that the caliber of this right angle hole be equal to, or just barely greater than, that of the shank of the screw because there must be only the slightest amount of play when the screw is seated in the hole.

The screw, like the nail, is made of vitallium; and we have available screws 2, $2\frac{1}{4}$, and $2\frac{1}{2}$ inches long. (C, Fig. 1.) The one we used at first was patterned after the common wood screw with its counter-sunk head, long shank, and relatively short threaded tail. (Figs. 4A, B and C.) Later, however, the screw was improved. The head was rounded, the unthreaded shank was made thicker and shorter, and the threaded tail was lengthened. Thus, in the improved screw the head has a flat base. The diameter of the unthreaded shank (approximately $1\frac{3}{64}$ of an inch) is slightly greater than the greatest diameter of the threaded tail. Also, the shortened shank does not extend beyond the inferior border of the right angle hole in the nail head. (A, Fig. 3.) Consequently, the threaded tail begins immediately below the lower border of the hole. As a result, the threads bite into the lateral as well as the medial cortex of the femoral shaft and thus

aid in stabilizing the fixation device. (Fig. 4D.)

METHOD OF TREATMENT

Preoperative Management. As soon as the patient is admitted to the hospital,

the skin over the site of the injury is prepared by shaving, cleaning with green soap and water, and application of an alcohol dressing which is renewed the following day. Thus, preparation of the operative site takes two days. The patient, before he is

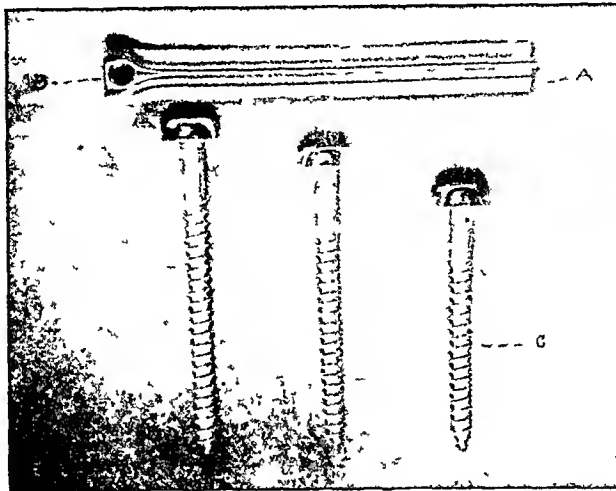


FIG. 1. A, modified three-flanged vitallium nail. Nails of three lengths—3, $3\frac{1}{4}$, and $3\frac{1}{2}$ inches—are used. B, right angle hole in nail head. C, improved wood screws, 2, $2\frac{1}{4}$, and $2\frac{1}{2}$ inches long. Notice rounded head with flat base, short shank, and long threaded tail of these screws. It should be stated, however, that the head is larger than is necessary. It need be only large enough to keep the screw from slipping through the right angle hole.

measures to combat initial shock are instituted. The injured limb is steadied with sandbags until it is deemed feasible to apply traction. Traction, when applied, is maintained by adhesive plaster. Enough weight is used to prevent shortening of the extremity and to decrease pain.

As a further precaution, all patients are carefully examined by an internist in order to rule out any co-existing disease not related to the injury which might make operation inadvisable. Obviously, a patient with a grave organic disease, which has already been aggravated by the injury, should not be subjected to the added shock of operative interference. Such a patient should be kept as comfortable as possible by means of bed rest and traction, and suitable supportive measures should be instituted to improve his general condition.

When it is considered that operation can be carried out with reasonable safety,

taken to surgery, is given the usual sedatives.

Operation. Spinal block or gas inhalation anesthesia may be used. Novocaine infiltration is, however, satisfactory. But whichever agent is employed, it is important that it be started before an attempt is made to reduce the fracture. It is our practice to begin the anesthetic as soon as the patient is brought to the operating room and while he is still on the stretcher. This is done to obviate the pain which the patient would otherwise have when he is moved from the stretcher.

As soon as the patient is completely relaxed he is transferred from the stretcher to a fracture table, that is, a table which has both a pelvic and a perineal rest. Such a table facilitates the taking of roentgenograms during the course of the operation.

After the patient has been placed on the fracture table, anteroposterior and lateral

roentgenograms are taken to ascertain the position of the fracture. Manipulation and traction, if necessary, are then carried out,

instruments would show in the roentgenograms and obscure the view.

When the bone has been exposed, a

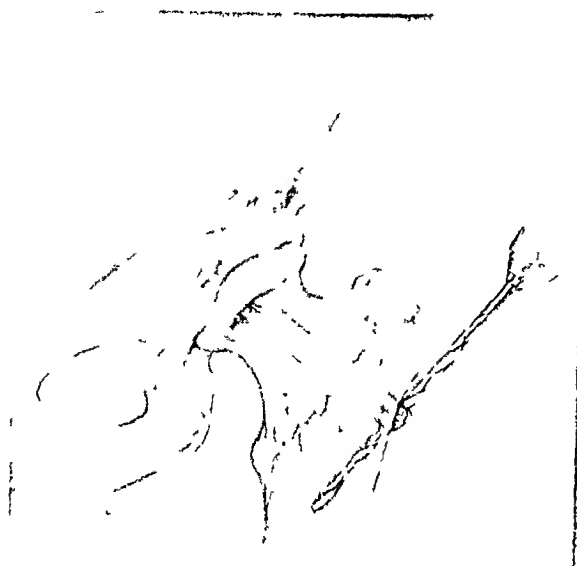


FIG. 2. Schematic drawing illustrating manner of drilling oblique channel in femoral shaft. Notice drill in right angle hole of nail head.

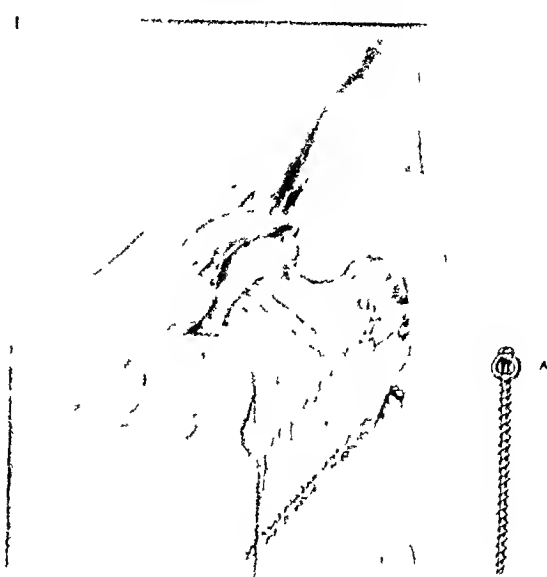


FIG. 3. Schematic drawing showing 90 degree angle support formed by proper placing of nail and screw. Notice, A, that shank of screw does not extend beyond inferior border of right angle hole and that threads begin immediately below hole.

and roentgenograms are again taken. If the roentgenograms show that the fracture has been satisfactorily reduced, the reduced position is maintained either by an assistant or by the traction apparatus attached to the table, and the open operation is then carried out.

The skin incision is made on the lateral aspect of the thigh, along the axis of the femoral shaft. In order to obtain sufficient exposure of the base of the greater trochanter and the upper part of the femoral shaft, the incision should be about 4 or 5 inches long, measuring from the tip of the trochanter to about 3 to 4 inches below the trochanteric base. However, when the patient is obese, it may be necessary to extend the incision above and below the greater trochanter.

The muscles and other underlying structures are then divided until the bone is exposed. As division of these structures progresses, bleeding is controlled with catgut ties or with the electric cautery rather than with hemostats because the metal

Kirschner guide wire, started at the base of the greater trochanter, is passed through the neck and into the head of the femur. The position of the wire is checked by roentgenograms. If it has not passed through the center of the femoral neck, another wire must be inserted. The incorrectly placed wire is not removed, however, until the second wire has been passed. By leaving it in place, it serves to correct the angle at which the second wire is inserted.

As soon as roentgenograms show that the guide wire is in a satisfactory position, a nail of suitable length, attached to a hollow driving rod, is slipped over the guide wire. But before the nail is driven in, it is important to make sure that the right angle hole in the head of the nail points in the direction of the axis of the femoral shaft. If it does, driving may be started. When the nail has been driven about half way into the bone, the driving rod is unscrewed and

the guide wire is extracted. This is done to prevent the possibility of bending the wire during the driving process. After the wire has been removed, driving is resumed with

the right angle hole in the head of the nail. (Fig. 2.) In this way there is less danger of deviating from the diagonal direction it is important to keep.

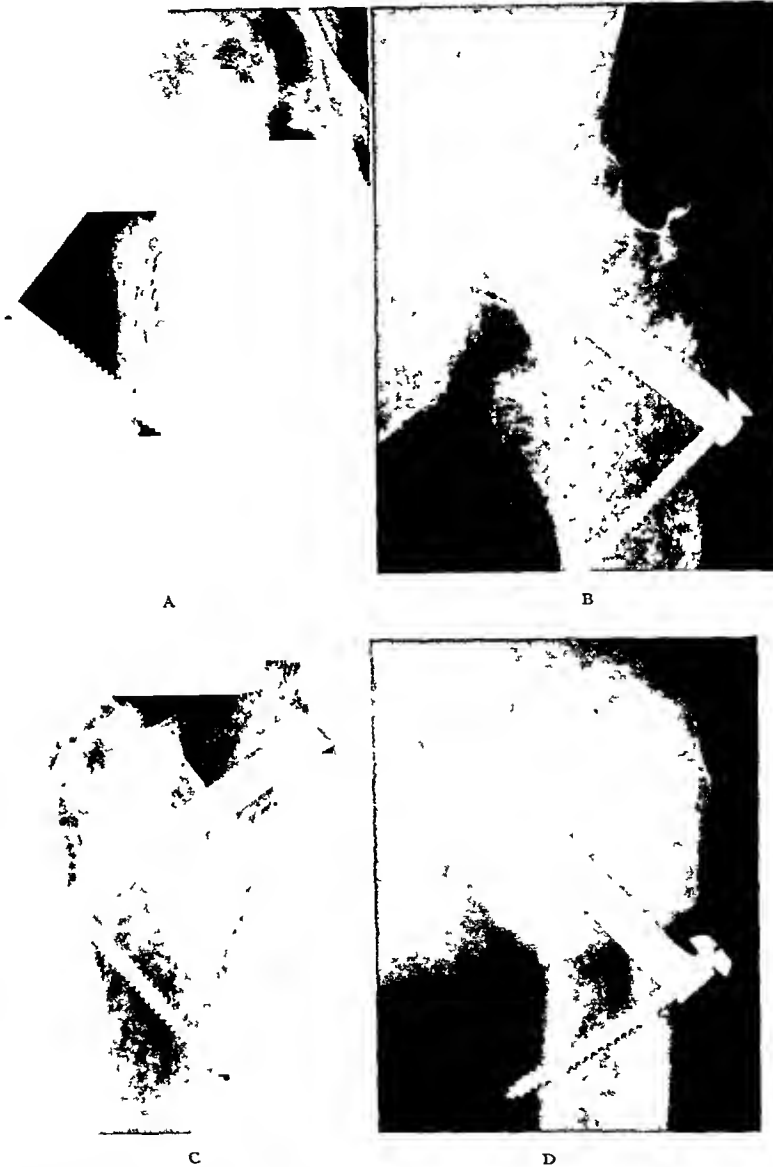


FIG. 4. Roentgenograms of patients treated by this method. A, B and C, show the common wood screw originally used. D, shows the improved screw. Each film was taken after the patient had been bearing weight for several months. The screws extend a little too far beyond the medial cortex in these cases.

a mallet, and is continued until the right angle hole in the nail head is on a level with the lateral cortex of the femoral shaft.

The next step in the operation is the drilling of the oblique channel through the femoral shaft. As has already been pointed out, this is done with the drill inserted in

Stabilization of the fixation device, it has been shown, is improved because the threads of the screw bite into both the lateral and the medial cortex of the femoral shaft. In order to insure still greater stabilization, it is desirable for the screw threads to bite into the walls of the channel as well.

Hence, the bore of the channel must, as is readily apparent, be slightly smaller than the caliber of the threaded tail of the screw. We have found that a channel of proper dimensions can be made with a drill having a diameter of either $1\frac{1}{64}$ or $\frac{5}{32}$ of an inch and a length of 5 or $5\frac{1}{2}$ inches.

Drilling of the cavity in the femoral shaft is continued until the surgeon can feel that the point of the drill has just barely pierced the medial cortex. When he feels that it has, and before he removes the drill, a piece of catgut is tied to the drill immediately above the superior border of the right angle hole in the head of the nail. Thus, when the drill is removed, it is an easy matter to measure the distance between the piece of catgut and the point of the drill in order to select the screw which most nearly approximates the length of the oblique channel. Although screws that extend beyond the medial cortex of the femoral shaft will cause no damage, we prefer to have no more than the tip of the screw protrude beyond the cortex. For this reason we keep on hand screws of varying length, that is, as previously stated, 2, $2\frac{1}{4}$, and $2\frac{1}{2}$ inches long. These have so far adequately filled our needs.

After a screw of suitable length has been selected, it is inserted in the right angle hole in the nail head, passed down into the oblique channel in the femoral shaft, and screwed securely in place. (Fig. 3.) Once the screw is in place, the wound is closed in layers and a dressing is applied. The dressing is held in place by means of a cotton elastic bandage. Neither a plaster cast nor traction is applied since they are not considered necessary.

Postoperative Care. Two or three days after the operation the patient is encouraged to sit up in bed. And a week post-operatively he is allowed to sit up in a wheel chair. At the end of two weeks the skin sutures are removed. The patient is then encouraged to begin weight bearing with the aid of crutches, and he is urged to continue this each day until he can get along without any assistance. Ordinarily all

walking aids can be discarded after four weeks. A young and active patient may start weight bearing sooner than two weeks after the operation if for any reason he should desire to do so.

Removal of the Fixation Device. It is, of course, not necessary to remove the nail and the screw. They may, however, be removed after bony union has taken place. When this is done, the exposure need be no greater than that which is necessary for removal of only the nail.

Roentgenography. It is our practice to have both anteroposterior and lateral films taken each time any step in the operative procedure is checked by roentgenography. We believe this is extremely important because a single view often does not give accurate information with regard to the position of bony fragments or of the internal fixation device.

In taking roentgenograms during the course of the operation, the technician drops each cassette into a sterile pillow slip which is held by the surgical nurse. Cassettes protected in this manner can be held in any position by an assistant without contaminating the operative field.

Since a number of films are taken during the course of the operation, it is of the utmost importance to shorten the time required for exposing, developing, and fixing the films. We have found that satisfactory films can be obtained in a minute and a half by overexposure and underdevelopment. In other words, by this method, about one-third more exposure is used than is required for films taken in the usual manner. And the solutions used for developing and fixing the films are heated. The temperature of these solutions is kept at 72°F . It may, however, be allowed to go as high as 76°F ., but it should not exceed this.

SUMMARY*

A simple internal fixation device for the treatment of intertrochanteric fractures of

* Since this article was submitted for publication, the author has performed the operation described

the femur is described. This device consists of (1) a three-flanged, vitallium nail, with a channel throughout the length of its shaft and a right angle hole in its head, and (2) a vitallium wood screw. When assembled, the nail and the screw form a 90 degree angle support which makes possible early weight bearing.

Included also is a detailed description of the relatively simple technic of insert-

therein on seven more patients with intertrochanteric fractures of the femur and on two patients with fractures of the femoral neck, making a total of twenty-two patients treated by this method. The results obtained in the second group of nine patients have been as satisfactory as those in the first group of thirteen patients.

ing both the nail and the screw. The management of the patient before as well as after the operation is discussed. And a procedure for shortening the processing of roentgenograms during the course of the operation is outlined.

Thirteen patients have been treated by this method. All but one of them were able to start weight bearing, with the aid of crutches or a walker, approximately two weeks after operation and to discard all walking aids at the end of four weeks. There was no displacement of bony fragments. Morbidity was of little or no significance. Only one patient died; death in this instance occurred a month after operation as a result of bronchopneumonia.



AN essential principle in the care of compound fractures is that no treatment of the wound itself should be allowed to interfere with correct splinting.

FALLACIES OF BONE PLATING

R. D. JOLDERSMA, M.D.

Comdr. M.C., U.S.N. Ret.
Head of Orthopedic Service, U. S. Naval Hospital
SAN DIEGO, CALIFORNIA

WE surgeons in the United States appear to have the great weakness of being guided or almost controlled by dictums. A dictum, according to Noah Webster, is an "assertion or statement which claims to be or is authoritative." In other words, a dictum is an American method of putting something over. We have two kinds of dictums: The highly ethical dictums put out by our leading surgeons, telling us how things must be done and the plain dictum used by our firms to sell us something. Time after time an intern or young doctor will state, "never do this, always do that," and I ask him "Why?" The answer invariably is in the words of one of our latest popular tunes: "My professor done tole me." He has no real reason and probably has not enough mechanical knowledge to explain or give reasons.

Lane gave us our bone plates and they were used by many with varying success, but the plating was only an aid to reduction and the fracture still needed casting support. It did not expedite union and, most important, early return of function which could not just as well and rapidly have been obtained by simpler nonoperative methods.

In other words, the following difficulties appeared: (1) The plate was not mechanically strong enough to give absolute support. (2) The screws did not hold and were put in gently but not tightly as they might strip the threads. For this, the texture of the bone was blamed. (3) The fracture still required extensive immobilization and casting with resultant stiff joints and muscle atrophy. (4) The patient had been subjected to the risk of a major operation without expediting return of function.

About two years ago, Doctors Townsend and Gilfillan, of Los Angeles, perfected a bone plate, which from a mechanic's viewpoint, is almost perfect.

T AND G BONE PLATES

The plate is made of 18-8 stainless steel which is of great tensile strength. Structurally, it has angle iron bridge girder structure which gives it unusual strength. The screw holes are slots, so that screws can be put in at an angle if desired and so that at no time will an off-center drill hole pull the bones apart as it will do in most types of plates. The plate is ideal in transverse fractures for after the plate and screws are in place, the screws may be loosened in the distal fragment and the foot or knee bumped and so drive the fracture ends together. The screws slide in the slot and can be tightened and so give perfect end-to-end apposition.

A single plate of four or five holes is used on tibias and will sustain body weight even on oblique fractures. In the case of femurs, two plates, one nested on top of the other, are used on the lateral side, since due to the structure and mechanics of the femur, normal weight bearing gives a lateral bowing stress on the shaft of the femur. Also two nested plates, due to its structure, gives five times as much support to a femur as two single plates applied to opposite sides. The two plates together have a "leaf-spring" action.

APPLICATION OF THIS BRIDGE GIRDER

It has been proved experimentally that a screw will hold firmly in the bone if the screw is of strong material and has the proper threading.

Special Screws. The screws are made of 18-8 stainless steel, the same as the plate, but are machine threaded individually by

ERRORS IN TECHNIC CAUSING FAILURE

The drill must be No. 36 wire gauge. The drilled hole must go through both cortices.



FIG. 1A.

FIG. 1B.

FIG. 2.

FIG. 1. CASE 1. The patient was a parachutist, twenty-two years of age. The plating was done in four hours. No cast or support was used. He was on crutches with weight bearing in fourteen days and walked without a cane or crutches in four weeks.

FIG. 2. CASE 1. Showing union in eight weeks. The patient had perfect function and returned to duty in ninety-one days.

hand and not cast. This gives maximum strength. The thread on the screw is twenty to the inch because tests have shown this thread has the maximum holding strength for bone. The screw has a "tuk tap" end so that the screw cuts its own thread as it is turned into the drilled hole.

The bone is drilled through both cortices with a No. 36 drill (about $\frac{3}{64}$). The screw No. 6 (about $\frac{9}{64}$) is put in and gently turned (do not bear down on the screw) and it pulls itself in cutting its own thread as it goes. It is *important* not to bear down on the screw as you would on a wood screw but turn it gently as a machinist turns a tap die. After the threads are cut through both cortices, the screw can then, and must, be tightened as tight as it can be forcibly turned. If handled like machine screws, it can be removed and a longer or shorter screw inserted. The screw must go through both cortices.

Screws must be turned in gently for if pressure is used, the "tuk tap" end acts as a reamer and the screw will be loose. The screw must go through both cortices.

Finally, all the screws must be tightened as tight as possible before closing up. The screw must not extend beyond the distal cortex as results shown in three cases in which screws projected $\frac{1}{4}$ inch prove that this does not cause electrolysis or necrolysis but, contrary to belief, nature throws dense bone out around the screw ends, thus giving, in tibias, a much larger unsightly tibia. (Fig. 4.) In fractured femurs this, of course, is desirable.

So a plate strong enough to hold and screws capable of being handled like machine screws have been devised. As a result, no cast or support is needed and patients are allowed up on crutches with light weight bearing, in the case of tibias, in two weeks, and in the case of femurs, in four weeks. No stiffened knees or ankles

and no muscle atrophy result; therefore, there is no loss of function and the patient returns to duty at an early date.

six weeks. In two months full weight bearing was allowed and almost complete repair was visible. Full union in three

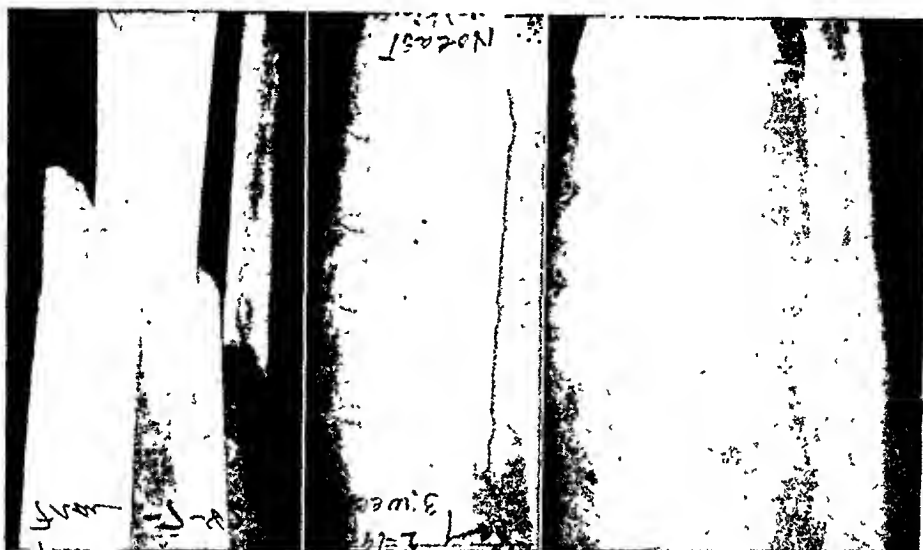


FIG. 3A.

FIG. 3B.

FIG. 4.

FIG. 3. CASE 11. Fracture occurred on January 7, 1942, and it was plated on January 27th after arrival at hospital. No cast or support was used. Reduction picture taken in three weeks after patient had fallen twice. Note the callus. The patient was on crutches in fourteen days and was able to walk and run in four weeks without cane or crutches and with full function.

FIG. 4. CASE 11. Note that too long screws were used and in four months nature had thrown bone around the end of the screws.

Failure in plating may be due to our own error in technic. We had two cases of tibia plating that required casting. In one case the screws did not go through the distal cortex. In the other case the surgeon pushed hard on the screws and stripped the threads. The screws were loose and did not give support.

We have plated fifteen cases of tibias and in fourteen cases no cast or support was used. The patients were all up on crutches in two weeks and all had marked callus and fracture obliteration in four weeks and were walking without crutches or cane. All had solid union in eight weeks. The tenth case did not have the screws through the distal cortex and so required casting for eight weeks. In all, fourteen femurs were plated, four of which were severely comminuted. All fourteen cases showed large amounts of callus and obliteration of fracture line in eight weeks and were allowed on crutches with weight bearing in

months was the rule. No cast or support was used.

ANSWERS TO ARGUMENTS

Screws will not hold in bone. In my series of thirteen oblique fractures of lower tibia and fibula, no cast was applied and patients were allowed on crutches with weight bearing urged in two weeks and were walking normally with no support, no crutch or no cane in four weeks.

Callus in lower third of tibia does not appear short of two months or union short of four months. All of our ten cases had heavy callus and obliteration of fractured line in four weeks and solid union in eight weeks.

Too perfect reduction delays union. We obtained, in all our thirteen oblique fractures, almost perfect apposition and had solid union in eight weeks. We concluded that by our previous methods absolute fixation was not obtained and friction re-

sulted in fracture site causing delayed union.

Metal will cause electrolysis or necrosis. This in our series of fifteen tibias and thirteen femurs and four ulnars plated was completely ruled out. In three cases in which screws were used that protruded $\frac{1}{4}$ inch through the bone, nature provided callus and finally bone completely around the ends of the protruding screws. (Fig. 4.) The x-ray department reported that in all thirty-two cases no evidence of any loosened screws or necrosis was seen except in the one case in which screws did not go through both cortices. Our conclusion is that with the old type screw the failure to hold made the loose screw act as a foreign body and cause necrosis.

Bone cannot be plated and left without other support. All thirty-two of our cases, both tibias and femurs, had early weight bearing and no cast or brace was used. Due to the strength of the plate and perfect holding power of the screws, perfect reduction was obtained and held. In fact, one case of oblique fracture of tibia and fibula of the lower third, the patient fell down twice in his third week after plating with no bad results physically as shown by x-ray. (Fig. 3.)

Bone defects due to loss of fragments in the fracture line tends to delay union. Again, I state, that this is due to the fact that we have never had complete rigid fixation. In a number of our cases with bone defects in the fracture site, the defect has closed in rapidly. The absolute fixation allows an undisturbed blood clot to organize and furnish a bridge for callus formation. (Figs. 5, 6, 7, 8 and 9.)

WHEN TO PLATE

1. Acute fractures if seen within five hours and if clean are plated immediately and have given excellent results.

2. Fractures over six hours are not plated but temporarily cast or put in traction for fourteen days before plating. After fresh tissue destruction, we know, due to our knowledge of healing process, that we

first have an inflammatory stage which lasts from three to five days and then the second or reparative stage which may last



FIG. 5.

FIG. 6.

FIG. 5. CASE III. Note that third screw from the top lies under the plate. The two fragments were first fixed with a screw and then plate applied over the top. No cast or support was used.

FIG. 6. CASE III. Shows dense callus and repair in eight weeks at which time the patient was walking with a cane.

through the twelfth day. All cases plated after two weeks showed extensive callus in three weeks after plating, so practically no time is lost by the two weeks delay. Under this class also comes all shock cases which should, and must, be treated palliatively.

3. Compound fractures are not plated. I can see no reason or excuse for immediate plating. If, after thorough débridement, closure and temporary traction or casting, you get primary healing in two or three weeks, plating can then be done safely; and according to previous statement, none if any time is lost in final union. On the contrary, if infection persists, you have a disastrous osteomyelitis. From personal



FIG. 7.



FIG. 8.



FIG. 9.

FIG. 7. CASE IV. Comminuted rotated T fracture through condyles.

FIG. 8. CASE IV. Plated two weeks later. Note bony defects, also that plate and two screws are inside capsule of knee joint. Patient was on crutches in three weeks with light supportive cast about knee. In five weeks the cast was removed. There was no fluid in the knee joint and about 22 degrees motion. Light weight bearing motion in the knee was urged.

FIG. 9. CASE IV. X-ray at twelve weeks showed 48 degrees motion in knee joint; no fluid in knee joint. The patient was walking with a cane. Note filling in of bone defects. At four months the patient had 70 degrees of motion.



FIG. 10. CASE V. Oblique ulnar at four weeks. No cast or support was used and patient had full function and use in two weeks.

observation, I have found that compound fractures treated by the two pin fixation and Orr method, after healing, do not have residual sequestration and chronic recurrent osteomyelitis. I have also noticed that all the cases of recurrent chronic osteomyelitis that came in for recurrence of infection have a history of previous plating or wiring.

In my opinion, following physiological thinking, when a bone is fractured, it splits in a natural line of cleavage that nature can handle and take care of even in the presence of infection; but if you add numerous drill holes through all the layers of the bone and through the medullary canal, it gives nature more than she can take care of and you have a resultant chronic sequestered condition.

OPERATIVE TECHNIC

The dictum of two day preparation has been abandoned for all operative work. The operative field is shaved very lightly so as not to damage the skin. It is then washed with soap and water for ten minutes using cotton sponges only. The field is then cleansed with ether and one light coat of methiolate is conceded due to custom. A tourniquet is not used on any patient as we prefer to dry our field as we go along and not have a postoperative wound or knee bulging with a bloodclot. Towels are not used on the wound edges, first, because the towel clips make numerous puncture wounds of the skin inviting infection and, secondly, towels into wounds tend to hold all débris and blood in the

operative field. The least possible amount of catgut is buried. Muscles and periosteum are not sutured. Fascia and skin are closed by silk. Close, accurate skin approximation is arrived at. We treat the skin respectfully and expect it to return the favor. No antiseptics are ever used in any wounds clean or compound. In other words, we have two dictums which we adhere to: "Cleanliness is next to Godliness" and "ain't nature grand" if given half a chance.

In eight months we have plated thirteen femurs, fifteen tibias and four ulnars with no sign of infection. Also in the last ten months we have performed 773 operations with no infection.

CONCLUSION

1. We have described an ideal structurally perfect plate and a mechanically perfect screw for boney structure.
2. Bones can be perfectly reduced and rigidly held.
3. Due to rigid fixation perfect length and alignment can be obtained and held.
4. Due to absolute fixation, early boney union is obtained at least 50 per cent earlier than any other method.
5. Due to rigid fixation, no brace or casting is needed. Ankylosis and muscle atrophy are absent.
6. Return to full duty in tibia fractures is reduced from seven months to three months, in femurs from nine months to five months.



A STUDY OF THE UTERINE CANAL BY DIRECT OBSERVATION AND UTEROGRAM

W. B. NORMENT, M.D.
Surgeon at Wesley Long Hospital
GREENSBORO, NORTH CAROLINA

THE study of uterine bleeding from an endocrine viewpoint has made much progress during the past few years. However, the detection of uterine polyps or submucosal myomas as a possible cause of uterine bleeding is very difficult. Probably no other organ is more susceptible to new growths, with less means of detecting them, than the uterus. X-ray studies or other laboratory methods are at our disposal for the diagnosis of tumors in other systems of the body. However, the submucosal myoma or polyp is usually found by the curet which is uncertain. Bimanual examination often reveals a normal sized uterus, with a smooth contour, and it is assumed that no myoma is present. Various types of therapy are given with no relief. The myoma that is definitely palpable is too often not the cause of the uterine bleeding, unless it protrudes into the uterine canal.

DIRECT OBSERVATION

During the past two years we have used two methods whereby the submucosal myomas protruding into the uterine canal, or the polyp of the uterus may be detected. A thin rubber tissue bag was attached to the end of a cystoscope and inserted into the uterine canal. The bag was then inflated with air. By this means the uterine canal could be visualized as the rubber tissue bag is transparent when moistened. This method was not used on the human, however, as it was found difficult to insert this instrument through the cervical canal and obtain good vision. The special foroblique telescope was then used, the rubber tissue bag being attached to a sheath similar to that of a peritoneoscope. With a small rubber band the bag

was firmly fixed to the sheath so that there would be no risk in becoming detached in the uterine canal. A long obturator was constructed which permitted the insertion of the sheath with less difficulty.

Following the usual vaginal preparation the cervix is well dilated, and the sheath with bag attached is inserted well into the uterine canal. The obturator is then withdrawn, following which the special foroblique telescope is inserted. A small rubber washer is used over the proximal end of the telescope to prevent the escape of air when the bag is inflated.

Water or air may be instilled into the bag by means of a small syringe. A sufficient pressure in the uterine bag is usually obtained when the pressure is felt on the plunger of the syringe. Following the dilatation of the bag the telescope is then inserted as far as it will go into the uterine canal. By this means a greater part of the uterine canal may be visualized. We have used this method of observation on numerous uterine specimens and more recently on the human. Even when there is profuse uterine bleeding the pressure of the air or water media in the bag permits accurate observation of the endometrium in its natural color. This would not be possible unless some method were used, as the rubber tissue bag, to dilate the uterine canal and control bleeding. A more satisfactory instrument is being made with a smaller sheath. By this method an accurate observation of the uterine canal may be made, similar to a cystoscopic examination of the bladder.

A second method of study of the uterine canal is by the *uterogram*. We had constructed a small rubber tissue bag which

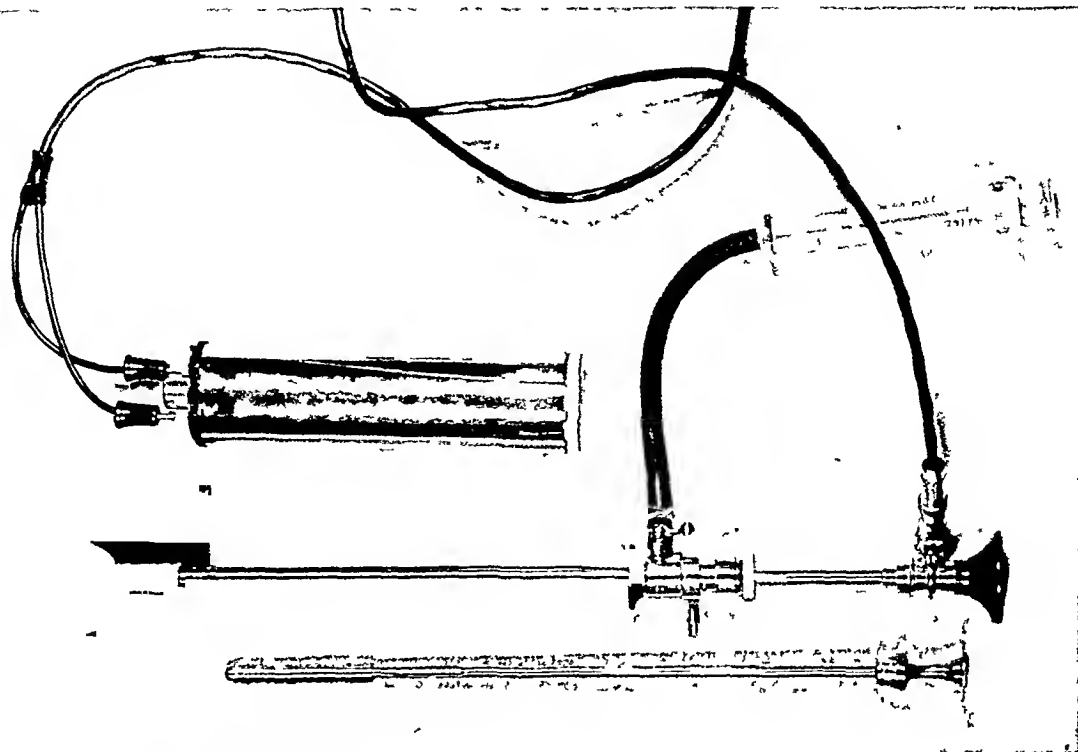


FIG. 1. Photograph of instrument used for direct observation of the uterine canal.

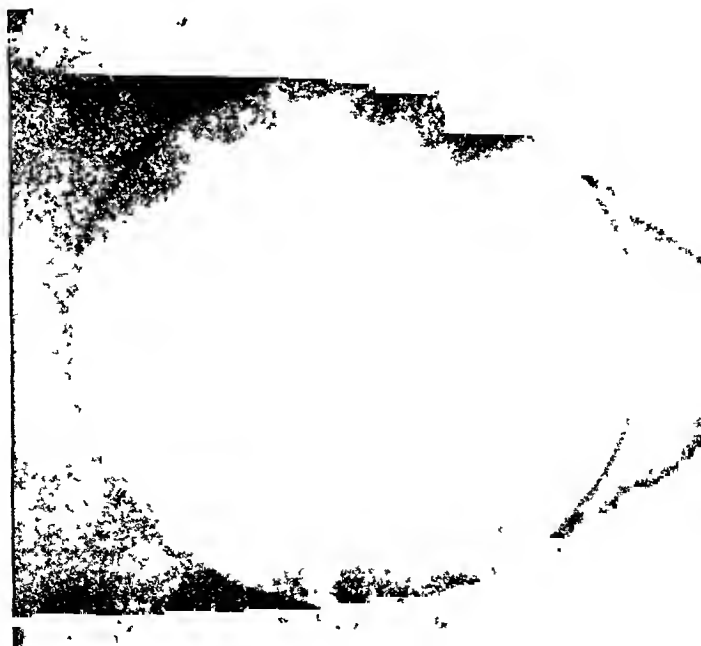


FIG. 2. Photograph of interior of fundus of uterus made through the instrument and bag.

was attached to the end of a No. 18 catheter. This was inserted into the uterus with the idea that a polyp or submucosal



FIG. 3 Normal uterine canal.

myoma protruding into the canal would depress the bag and reveal the defect by x-ray study. The patients were prepared

tissuc bag, attached to the catheter, was inserted into the uterus. It was found that when the bag was moist it was inserted with ease by a uterine probe. Air was used as the media in the bag. To determine the position of the bag in the uterus, a small amount of air, usually 6 to 10 cc. was instilled into the bag before the patient left the operating room. If there was some difficulty in instilling the air, the bag was withdrawn and re-inserted. The size of the bag or balloon used varied with the depth of the uterine canal. This is usually ascertained by inserting a uterine probe into the canal and using a bag three-fourths the length of the depth of the uterine canal. However, we found later that there is too often an excess amount of bag inserted into the uterus rather than too small a bag. It is probably safer to use a bag half the length of the depth of the uterine canal as the cervix is not occupied by the bag.

Due to the fact that an ordinary No. 18 catheter was used, we had some difficulty with the patient expelling the bag in reaction from the anesthesia. To overcome this we usually packed strips of gauze around the catheter in the vagina to prevent expulsion of the bag when the patient reacted.



FIG. 4. Anteroposterior view of normal uterine canal in retroverted uterus



FIG 5. Posterior-anterior view in same patient as in Figure 2.

similar to a preparation for dilatation and curettage of the uterus. Under gas anesthesia the cervix was well dilated, the uterus curetted, the scrapings sent to the pathologist, following which the rubber

The following day the patient was taken to the x-ray room, the bag instilled with air again, and antero-posterior, lateral x-rays, postero-anterior and lateral x-rays over the sacroiliac region were made. By this method the entire circumference of

the bag was covered with x-ray studies; and if there were defects in the contour of the bag, it could be assumed that there

original bag and did not conform with the outline of the uterine canal; because of this we discarded the use of this bag. Differ-



FIG. 6.

FIG. 7.

FIG. 8.

FIG. 6. Lateral view of retroverted uterus, normal canal but depth of triangle shortened; compared with Figure 1.

FIGS. 7 AND 8. Variations of normal canal.



FIG. 9. Lateral view of normal uterine canal.

FIG. 10. Normal uterine canal, but too large bag causing wrinkling of bag.

FIG. 11. Normal uterine canal with prominent cornu.

was a possible submucosal myoma or polyp. The defect, if found, is usually fairly definite and with a wide base. Too often a small defect is seen on one contour of the balloon due possibly to an excessive amount, or wrinkling of the bag in the uterine canal. This can be overcome by releasing the air in the bag and further x-ray studies to determine if the defect persists. If a flat plate previous to insertion of the air into the balloon reveals much gas in the intestinal tract in the area of the uterus, it is often difficult to detect the outline of the air media from the gas in the intestinal tract. To remedy this, we later had a bag constructed with an opaque lining. This bag was used several times but it was found to be less pliable than the

ent opaque medias were then used in the bag to outline the uterine canal. Diodrast or sodium iodide were most often used. If, with the 12.5 per cent sodium iodide, or diodrast, a definite defect is found on one contour of the balloon or bag, then a weak solution, 3 to 4 per cent of sodium iodide is injected into the bag in an attempt to determine whether the submucosal growth or polyp will displace the dye through the weaker solution as in gallstones in a gallbladder x-ray. However, we believe that it is probably best to use the 12.5 per cent for the original study as the weaker solution does not outline the contour very definitely. The weaker solution is, however, valuable in checking on the original examination; because if there is a defect in the

original and a displacement of the weaker dye in the second study, it is believed that there is probably a growth protruding into



FIG 12. Large uterine canal but normal in outline

the uterine canal. In some of our studies we instilled a small amount of sodium iodide, which was followed by an injection of air, thinking that probably the air would

that the vagina was packed very firmly with gauze, expelled the bag into the vaginal vault in the reaction from the anesthesia. To overcome this we used a small mushroom catheter to which the bag was attached by a fine silk thread. This bag was inserted by the use of the uterine probe in the eyelet of the mushroom catheter similar to insertion in the bladder. This method prevented the expulsion of the bag into the vaginal cavity, as the mushroom tip is beyond the internal os. At times small particles of air are seen in the x-ray study, when 12.5 per cent sodium iodide is used. Even when the bag is well aspirated and clamped before insertion of the dye there will often be seen particles of air in the bag which fail to outline the contour. This is best remedied by using the two-way mushroom catheter and instilling the dye in one opening and allowing it to return through the other until there is no air expelled. Following this, one end is clamped and then the dye inserted as in the original method. This gives a much clearer picture and is free of any air globules in the x-ray study.

Pentothal sodium intravenously has been used entirely recently in the place of gas



FIG 13 A, heart-shaped deformity of bag due to polyp protruding into canal, air used as media, previous curettement missed this polyp. B, uterus showing polyp in top of uterine canal

displace the dye around the edge of the bag and outline the contour of the uterine canal in this way. This did not prove successful as the dye was displaced by the air into one cornu or the other and did not give a clear outline.

Some of the patients, in spite of the fact

anesthesia, as there is very little discomfort following the procedure and also the x-ray studies can be made much more quickly than when the patient is given nitrous oxide.

The advantages of this procedure over the usual method, as in a salpingogram of

instilling dye into the uterine canal, are that the numerous folds of the uterine canal are pressed out and the bag can be inserted,

tubes. There is a constant pressure in the uterine canal when the bag is used so that repeated x-ray studies from different angles



FIG 14 A, deformity of canal due to a submucous myoma B, uterus entirely involved with submucous fibroid.

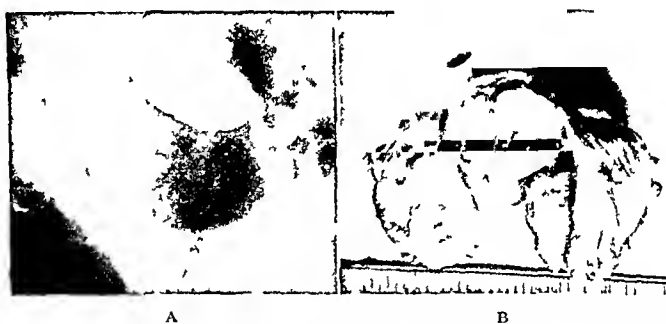


FIG 15. A, egg-cup deformity of bag due to a submucous fibroid protruding into canal B, specimen showing the large submucous fibroid



FIG 16. A, polyp of uterus which had caused much uterine bleeding, B, x-ray study of specimen with bag revealing defect on lateral view but not anteroposterior view.

the tube clamped and different angle x-ray studies of the uterine canal can be made which would be impossible with the ordinary method as in a salpingogram. By this method there is no leakage of the dye out of the cervical canal or the Fallopian

give the same sized contour which may be compared with each other.

We have seen no ill effects of this method. When the patient complains of abdominal pain the injection of the dye is stopped. The bag has been purposely left in three

or four days, but there has been no untoward reaction more than there would be associated with ordinary dilatation of the



FIG. 17. Two-way mushroom catheter with bag.

cervix. The removal of the bag is very simple and without any discomfort.

We have found that there are many variations in the so-called normal uterine canal. Basically, it is of course an inverted triangle, but the proportions are often distorted to a certain extent in a normal canal. These are easily recognized after frequent use of the bag. For instance, one cornu might protrude further than the other cornu. Or in an antiflexed or retroverted uterus the length of the triangle may be shortened. However, a growth of any proportion should distort the bag so there should not be much doubt of its presence. We have several patients who have been curetted and the growth not detected, following which the bag produced a filling defect.

This method of study is also valuable in the case of uterine bleeding where a definite fibroid is palpable, as it will help determine whether the fibroid is the real cause of uterine bleeding. Too often a fibroid is palpable, and yet the cause of uterine bleeding is some endocrine disturbance. If by bimanual examination the contour of the uterus feels smooth, and following insertion of the bag no defect is found to suggest a submucosal myoma or polyp, other methods of investigation should be carried out to determine the cause of

bleeding before the patient submits to surgery.

In those patients in whom there is rather profuse uterine bleeding following the x-ray examination with the bag, it is best to leave the bag remaining in the uterine canal to act as a hemostatic agent. This is done by inflating the bag with a small amount of air and clamping the end of the tube, allowing the air to remain in the bag, producing pressure against the walls of the uterus. This method is similar to that used in superpubic prosectomy to control bleeding postoperatively. It is a more desirable way than the method by which the uterine canal is packed with gauze. After the bag has been inflated for a period of one to two days, pressure may be released and if there is no further bleeding the bag may be removed. After a period of time following release of the air there is a tendency toward bleeding; then the bag may be re-inflated and the bleeding controlled.

Another use for the uterine bag that we have found is that of determining the presence or absence of involvement of the uterus in large abdominal masses filling the pelvis, in those patients in whom it is difficult to determine whether the mass originates from the uterus or whether it is extra-uterine. Under pentothal sodium the bag can be inserted, a small amount of dye instilled into the bag and in this way determine whether the mass is probably uterine in origin or whether it is extra-uterine.

We believe by the use of these two methods that the submucosal myoma or polyp may be more easily detected than by relying on the curet which is not reliable. Also just as important it will aid in determining whether the palpable fibroid on the serosal surface is the cause of uterine bleeding or whether it is just a coincidence and that the bleeding is referable to an endocrine disorder.

REFERENCE

1. NORMENT, W. B. and APPLE, E. D. The diagnosis of submucosal myomas and polyps of the uterus. *South. Med. & Surg.*, 103: 373-375, 1941.

ANESTHETIC DEATHS*

A FIVE-YEAR REPORT

FRANK N. DEALY, M.D.

Director of Surgery, Queens General Hospital

JAMAICA, NEW YORK

AROUSSED by the reports made to it of accidental deaths in the operating room of patients under spinal anesthesia, the Medical Board of Queens General Hospital determined to investigate the entire question of anesthetic deaths and for that purpose appointed a Committee to study all such cases which had occurred since the opening of the hospital in November, 1935. This report was originally submitted in May, 1940, and covered the period up to that time from the hospital's opening date, November 18, 1935. During the two months of November and December of 1935, the first two of the hospital's existence, there were no operating room fatalities, only seventy-five inhalation anesthetics and only six spinal anesthetics being given, fortunately with no untoward results. The original report, therefore, was later supplemented and for the purposes of this paper, omitting these first two months, covers the five-year period from January 1, 1936, to January 1, 1941.

In this study all patients, regardless of the apparent cause, who had actually died in the operating room or immediately thereafter were grouped together and then from this group were eliminated those cases in which the anesthetic obviously had played no part in the fatality. This left for further consideration a group of cases in which for one reason or another the anesthetic could not readily be freed from the suspicion that if not the actual cause of the fatality it had at least contributed materially toward it.

It is comparatively simple to incriminate an anesthetic if the patient dies on

the table; it is practically impossible, however, to evaluate postoperative sequelae—pulmonary, renal or hepatic—for which the anesthetic may in reality have been the primary though insidious cause or to demonstrate a causative relationship between such sequelae and the administration of the anesthetic agent employed. Late postoperative deaths may indeed occur in which the anesthetic, though entirely escaping suspicion, is the actual causative factor. Any attempt to determine the relative safety of the various anesthetic agents, therefore, to be reliable should include the late fatalities as well as those which occur sometimes with such inexorable promptness.

TABLE I
ANESTHETICS ADMINISTERED
(Exclusive of Local and Intravenous Anesthetics)
Total Number 19,529

Year	Inhalation	Spinal	Rectal
1936	2,573	397	0
1937	2,887	440	8
1938	3,973	561	15
1939	4,092	704	13
1940	2,748	1,091	27
Totals.....	5,273	3,193	63

Leaving entirely out of consideration, however, all possible late anesthetic deaths, this study is limited to those cases which were to all intents and purposes operating room fatalities; with the hope of indicating, at least partially, to what extent the anesthetic agent, as well as its method of administration, were responsible for the outcome.

* From Queens General Hospital, Jamaica, N. Y.

During this five-year period then, between January 1, 1936, to January 1, 1941, exclusive of locals and a few intravenous cases, 19,529 anesthetics were administered in the operating rooms of Queens General Hospital as shown in Table I.

From Table I it can be seen that of the total number of anesthetics given, 83.3 per cent were inhalation anesthetics and 16.3 per cent were spinal.

During this same period twenty-nine deaths occurred in the operating room or within such a short time after the completion of the operation as to justify investigation. These fatalities were as follows (Table II):

TABLE II
OPERATING ROOM FATALITIES
Total Number 29

Type of Anesthesia	Fatalities
None.....	3
Local.....	5
Rectal.....	6
Inhalation.....	8
Spinal.....	7

These twenty-nine cases were thoroughly studied with the view of determining what rôle, if any, was played by the anesthetic in connection with the fatality. Age, sex, diagnosis, operative risk, complicating pathology, operative procedure as well as the various factors directly concerned with the anesthetic itself were all included in this analysis. As a result and with the frequent additional aid of autopsy findings, it became evident that in eleven of these twenty-nine cases the outcome had not been affected by the anesthetic. These eleven cases were, therefore, rejected from further consideration. None of the cases that had received a spinal anesthetic, however, was rejected, as it was believed that each of these, regardless of circumstances, should be exposed in a full and searching examination.

There remained eighteen cases, therefore, including all of the spinal anesthesia

cases, in which the anesthetic itself or its administration could not be disregarded. Table III, therefore, represents the cases in which the anesthetic was held as a possible causative factor in the fatality.

TABLE III
POSSIBLE ANESTHETIC DEATHS
Total Number 18

Case	Diagnosis	Anesthetic		
		Inhalation	Spinal	Rectal
1	Recurrent carcinoma of tonsil.....	..	..	x
2	Chronic appendicitis.....	x		
3	Toxic adenoma of thyroid	x		
4	Perforative diverticulitis..	..	x	
5	Intestinal obstruction.....	..	x	
6	Strangulated ventral hernia.....	..	x	
	Perforation of cecum			
7	Brain tumor.....	x		
8	Prostatic hypertrophy....	..	x	
	Diabetes			
9	Suppurative parotitis....	x		
	General peritonitis			
10	Periarteritis nodosum....	x		
11	Carcinoma of floor of mouth.....	..	..	x
12	Gangrenous appendicitis..	..	x	
	General peritonitis			
	Intestinal obstruction			
13	Cerebellar tumor.....	..	..	x
14	Bartholin cyst.....	x		
15	Empyema of gall bladder.	..	x	
	Common duct stone			
	Obstructive jaundice			
16	Carcinoma of pancreas....	..	x	
17	Brain tumor.....	..	..	x
18	Acute appendicitis.....	x		
Total number of cases.....		7	7	4

Rectal Anesthesia. Under rectal anesthesia there were four fatalities as shown in Table IV.

CASE I. This patient though considered a fair preoperative risk, was readmitted to the hospital for a ligation of the external carotid artery because of bleeding from a sloughing recurrent carcinoma of the tonsil. At the time of admission he was unable to open his mouth more than half an inch. He had had heavy radiation on previous admissions: (1) May 12, 1936, radiation 3,000 R. on each side completed; (2) June 18, 1936, evipal was given for the

insertion of gold seeds of radium, but because of rigors and cyanosis the attempt was abandoned; (3) June 24, 1936, an intratracheal anesthetic was attempted but given up because of inability to pass the tube. Under partial general anesthesia the gold seeds were finally inserted.

1938 for a cerebellar tumor at which time a cyst was removed. Under avertin, upon the opening of the dura, the patient suddenly stopped breathing. At autopsy, although a massive cerebellar cyst with internal hydrocephalus was found, the case was considered as an anesthetic death.

TABLE IV
FATALITIES UNDER RECTAL ANESTHESIA

Case	Hosp. No. Date of Death	Age	Sex	Diagnosis	Risk	Anesthesia	Operation
1	11561 12-17-36	46	M	Recurrent carcinoma of tonsil	Fair	Avertin	Ligation of external carotid
2	73583 11-18-39	56	M	Carcinoma of floor of mouth	Bad	Rectal ether	Neck dissection incision only
3	68715 2-1-40	7	M	Cerebellar tumor	Bad	Avertin	Craniotomy
4	A 12695 9-14-40	30	M	Cerebellar tumor	Fair	Avertin and local	Ventriculogram and craniotomy

Because of these previous difficulties, avertin, 90 mg. per Kg. was chosen as the anesthetic on his last admission. It was administered at 2:40 P.M., December 7, 1936. The operation was begun at 3:00 P.M., and despite the difficulties of dissection of the heavily radiated tissues, the external carotid was indentified and ligated, the operation being completed at 4:40 P.M. Throughout the operation the respirations were poor, the pulse weak and rapid. Upon the removal of the pharyngeal tube after operation, the patient ceased breathing. An effort was made to pass the Flagg intratracheal tube, but this was physically impossible. Artificial respiration, adrenalin, carbon dioxide and oxygen were all unavailing. The patient died at 5 P.M.

CASE II. This patient, a problem from any anesthetic standpoint, was readmitted for a neck dissection for lymph-node metastasis from a previously fulgurated carcinoma of the floor of the mouth. On his previous admission he had almost died from pulmonary complications following inhalation anesthesia. Rectal ether was administered. A fatality occurred, however, before anything more than a skin incision could be made, it being very questionable whether this last operative effort should ever have been made.

CASE III. This patient, a seven year old boy, had had a posterior craniotomy done in

CASE IV. This thirty year old male patient was admitted to the Medical Service with a history of occipital headaches associated with vomiting for the preceding six months. There had also been left lumbar pain together with urinary difficulties as well as weakness of the left leg and a tendency to fall to the left. After a complete study of the case, a diagnosis of cerebellar tumor together with rheumatic heart disease and hypertension was made. Under avertin anesthesia, 60 mg. per Kg. of body weight, supplemented by local infiltration, and after a ventriculogram, which showed a massive internal hydrocephalus, an exploratory craniotomy was attempted. Before the skull flap was elevated, however, serious respiratory difficulties arose. The operation was discontinued, measures of resuscitation employed and the patient placed in the respirator. Despite all efforts, however, the patient died four hours after the operation had been begun. No autopsy was performed, the Medical Examiner's diagnosis being "brain tumor, respiratory and circulatory failure. Death under avertin and novocain anesthesia."

In these four cases, therefore, done under rectal anesthesia, while appreciating the pathology and admitting the gravity of the problem, it is difficult to exonerate the

anesthetic in an estimate of the factors leading to the fatality.

Inhalation Anesthesia. The seven fatalities occurring under inhalation anesthesia during this period are tabulated in Table v.

thyroid. Under medical care, though followed also by the Surgical Service, the man's condition gradually improved, until on December 23, 1937, twenty-five days later, it was believed both by the Medical and Surgical Services that

TABLE V
FATALITIES UNDER INHALATION ANESTHESIA

Case	Hosp. No. Date of Death	Age	Sex	Diagnosis	Risk	Anesthesia	Operation
1	33521 1-7-37	18	F	Chronic appendicitis	Good	N ₂ O-O ₂ ethylene, ether and O ₂	Uncompleted appen- dectomy
2	36412 12-23-42	55	M	Toxic adenoma of thy- roid	Poor	Intratracheal cyclo- propane	Subtotal thyroidec- tomy
3	67596 5-17-38	3½	M	Brain tumor	Poor	Ethylene	Decompression
4	92704 9-16-39	9	M	Periarteritis nodosum	Poor	N ₂ O-O ₂ 2-3 min.	Muscle biopsy not per- formed
5	99230 9-1-39	42	F	Suppurative parotitis general peritonitis	Bad	N ₂ O-O ₂ 2-3 min.	Incision and drainage of parotid
6	2031 2-26-40	44	F	Bartholin cyst	Fair	N ₂ O-O ₂ Ether	Excision of cyst
7	79801 10-24-40	2	F	Acute appendicitis with perforation	Poor	Ethyl chloride and ether	Appendectomy

CASE I. A colored girl, eighteen years of age, was admitted to the hospital on December 29, 1936, with a history of continuous pain in the right lower quadrant accompanied by vomiting on two occasions, for a period of eight days prior to admission. There was also a history of injury due to a blow in the abdomen by a younger brother. She remained in the hospital under observation for nine days, following which, after a medical consultation, with the diagnosis of chronic appendicitis, an appendectomy under general anesthesia was done. Anesthesia was begun with nitrous oxide and oxygen, ethylene and ether together with oxygen subsequently being used. There was no difficulty in induction, and for fifteen minutes the anesthetic was taken well. At the end of that time the pulse was suddenly gone and despite the usual measures for resuscitation the patient promptly died. As the result of autopsy by the Medical Examiner, the conclusion was reached that this was an ethylene-ether death during operation for chronic appendicitis.

CASE II. A male, fifty-five years of age, was admitted on the Medical Service on November 29, 1937, because of congestive heart failure, with marked cyanosis, dyspnea and tachycardia, associated with a toxic adenoma of the

operation should be undertaken. Under intratracheal cyclopropane anesthesia, therefore, a subtotal thyroidectomy was done, the operative time being one hour and thirty-five minutes. No operative difficulty was encountered. There was no hemorrhage, no embarrassment of respiration, no appreciable change in the pulse rate or blood pressure throughout the entire operative procedure. Upon the completion of the operation, however, during the application of the dressing, the patient suddenly died, and though an autopsy was held there were no findings to explain the result. The operative risk in this case from the earliest observation was known to be great, more, however, due to the cardiac decompensation than to the thyrotoxicosis itself. If there was too much surgery, there was at least no clinical evidence during operation to indicate the need for a multiple-stage procedure. Who can deny, however, that the cyclopropane, itself, through its depressant cardiac effect may have been the real cause of this man's death? Perhaps local anesthesia would have been a wiser choice.

CASE III. A male child of three and a half years of age, in the hospital for eight days, was given ethylene in order that a decompression might be done for a brain tumor. The opera-

tion, however, was not completed as the child died from respiratory paralysis during anesthesia. No autopsy was performed though the cause of death was given as "brain tumor; respiratory paralysis due to anesthesia."

CASE IV. A boy of nine was under observation on the Pediatric Service for three months. He had had frequent attacks of asthmatic bronchitis for the past five years and was also suffering from rheumatic heart disease. A muscle biopsy was requested but never obtained as the child died two to three minutes after the induction of nitrous oxide and oxygen anesthesia given for the purpose. It was obvious from the pathology found at autopsy that death was imminent even without the anesthetic as a precipitating cause. With generalized vascular disease, hypertrophy and dilatation of both ventricles, extensive necrosis and hemorrhage of the myocardium and papillary muscles, hemorrhagic and fibrinous pericarditis with effusion, and other findings of serious disease, it is obvious that if the true status of this patient had been appreciated, and if surgery had then been undertaken, local anesthesia would have been used. The pathology was adequate, the anesthetic merely a precipitating cause for this patient's death.

CASE V. A female of forty-two, was admitted to the hospital with a suppurative parotitis and generalized peritonitis, having been operated upon elsewhere for gangrenous appendicitis. She was critically ill on admission, obese, toxic, with a draining abdominal wound, a temperature of 103°F. and a pulse of 120. A suppurative parotitis with extensive cellulitis was present. After four days in the hospital during which she received radiation therapy for her parotitis, an incision and drainage of the parotid were determined upon but two to three minutes after the induction of gas and oxygen anesthesia, with cyanosis and poor pulse, despite prompt efforts at resuscitation, the patient died. Though no autopsy was performed, the case was considered as a possible anesthetic death.

CASE VI. A markedly obese negro, with exertional dyspnea, rheumatic heart disease and essential hypertension with a blood pressure of 160/90, was admitted on the Gynecological Service on February 6, 1940, for the removal of a Bartholin cyst. She was seen by the Medical Service and after twenty days in the hospital was considered by them as a fair

operative risk. During the induction of a gas-oxygen-ether anesthetic, the patient stopped breathing, but upon the introduction of an airway the condition improved. Ten minutes after the operation was started the anesthetic was discontinued temporarily because of the presence of a pinkish, frothy fluid exuding from the mouth. The patient's condition throughout was poor. Sixty minutes after induction of anesthesia she died, postmortem examination revealing rheumatic valvulitis, myocarditis, chronic cholecystitis with cholelithiasis and hypertrophy of the uterus. The case was considered an anesthetic death.

CASE VII. This two-year old child admitted with a diagnosis of acute appendicitis with perforation, was prepared for operation, taken to the operating room and without the order of the resident, as the attending had not yet arrived, a general anesthetic was started. After ten minutes, the situation then being discovered, the anesthetic was discontinued. Twenty minutes later the anesthetic was resumed and the operation begun. An appendectomy was done, but before the completion of the operation, the patient ceased breathing, and despite all efforts at resuscitation, expired. Anesthesia in a case of acute appendicitis with peritonitis was given as the cause of death.

These deaths under inhalation anesthesia were not anticipated and came as a distinct shock. Most of these patients had been under prolonged observation and only later were subjected to surgery without the fear or expectation of an immediate mortality. Hidden pathology in marked degree was present in only one case, and in the others, no adequate cause other than the anesthetic could be found to explain the outcome. Inhalation anesthesia as well as all other types, has its dangers and along with all others demands constant, alert watchfulness in its administration.

Spinal Anesthesia. Under spinal anesthesia the following fatalities occurred, as shown in Table VI.

Real problems in anesthesia as well as in surgery are often met with in the small hours of the night when urgent cases are brought to the hospital for emergency operations. Some of these cases present many

difficulties, and the chances for successful surgery, if undertaken at all, frequently offer but meager encouragement. With surgery decided upon, however, the problem of anesthesia is next immediately encountered and despite earnest efforts sometimes fails of satisfactory solution.

the abdomen a diffuse peritonitis was found, but before any perforation could be located the patient collapsed and died. The abdomen was then closed. Autopsy in this case showed a perforative diverticulitis of the lower sigmoid with general peritonitis. There was a generalized diverticulosis, congestive edema of the

TABLE VI
FATALITIES UNDER SPINAL ANESTHESIA

Case	Hosp. No. Date of Death	Age	Sex	Diagnosis	Risk	Anesthesia	Operation
1	59341 1-14-38	40	F	Perforative diverticulitis	Bad	Pontocain 18 mg.	Laporotomy
2	50256 1-28-38	50	M	Intestinal obstruction	Poor	Pontocain 20 mg.	Laporotomy
3	63009 3-16-38	45	F	Strangulated ventral hernia. Perforation of cecum	Bad	Pontocain 20 mg.	Laporotomy
4	90252 4-17-39	83	M	Prostatic hypertrophy. diabetes	Bad	Novocain 120 mg.	Suprapubic cystotomy.
5	A-4060 12-1-39	54	M	Gangrenous appendicitis. Generalized peritonitis. Intestinal obstruction	Fair	Pontocain 20 mg.	Bilateral vasectomy Appendectomy
6	A-8534 2-29-40	56	M	Empyema of gall bladder. Obstructive jaundice common duct stone	Poor	Pontocain 18 mg.	No operation
7	73749 3-19-40	40	M	Carcinoma of pancreas	Bad	Pontocain 20 mg.	Cholecystojejunostomy uncompleted

CASE 1. The first of the patients to die under spinal anesthesia was admitted at 1:10 A.M., on January 14, 1938. The patient was a white female, forty years of age, desperately sick on admission, cyanotic, with severe abdominal pain, marked abdominal distention and tenderness, especially in the right upper quadrant. There was generalized rigidity and on auscultation a silent abdomen was found. This patient was first admitted to the Gynecological Service under the suspicion that she had a twisted ovarian cyst. This diagnosis not being substantiated, however, the patient was promptly transferred to the Surgical Service, meantime receiving intravenous glucose and other therapy calculated to improve the operative risk which was admittedly bad. The upper abdominal pain and tenderness were apparently confusing for with the mistaken diagnosis of perforated ulcer the patient was prepared for operation. Pontocain, 18 mg., was given, the patient being in slight Trendelenburg position, and operation begun. On opening

lungs, fatty infiltration of the liver and cardiac hypertrophy and dilatation. The case was considered by the pathologists as a spinal death, "desperate" pathological condition being present.

In retrospect and at noon-day this patient's only chance probably lay in conservative therapy and absolute, surgical non-intervention. Pontocain, given in Trendelenburg position is a dangerous drug, and doubtless caused this patient's death, though it is doubtful, with the pathological condition present, if operation under any form of anesthesia would have resulted differently. Admitting the difficulties, was it not a defect in surgical judgment in operating at all rather than an incrimination of an anesthetic agent, even though not employed with the most approved technic?

CASE II. A male, fifty years of age, in the hospital for two days with a partial intestinal obstruction, was likewise a spinal anesthetic death in the presence of extensive pathological disturbance. With face florid, semidyspneic, with abdomen markedly distended, a blood pressure of 164/110, with 3 plus albumin and 2 plus casts on urinalysis, the patient was considered a poor operative risk. He had had a previous laparotomy. After preliminary therapy, he was given pontocain, 20 mg., but collapsed shortly after the incision was made and died despite all efforts at resuscitation. At operation, however, an opening in the omentum was found, through which, though spontaneously reduced under the spinal anesthetic, four inches of ileum had apparently herniated. Autopsy showed extensive coronary sclerosis with myocardial fibrosis, the cardiac hypertrophy of hypertensive heart disease, atherosclerosis of the aorta, general arteriosclerosis, marked pulmonary congestion and edema and renal congestion. Cardiac failure in a patient subjected to spinal anesthesia for the performance of an exploratory laparotomy was given as the cause of death.

CASE III. A female of forty-five was in the hospital for seven hours with the diagnosis of acute appendicitis and a possible strangulated umbilical hernia. On admission she was acutely ill, toxic, obese, with a huge umbilical hernia, the "size of a watermelon." Blood pressure was 160/80, urinalysis showed albumin 2 plus, glucose 2 plus, and her blood count 21,800 with 86 per cent polymorphonuclears. She was put on the critical list before operation. At operation, under 20 mg. of pontocain, only an abdominal incision could be made and although along with other measures, the resuscitator was used for forty-five minutes, death followed. At autopsy the umbilical hernia was found to be strangulated and a perforation of the cecum, with a localized peritonitis, giving rise to the symptoms suggestive of acute appendicitis, was likewise found. This obese patient also had a paralytic ileus, a cholelithiasis with pancreatic changes, myocardial changes and a nephrosclerosis. "Strangulated ventral hernia with perforation of the cecum in an obese patient under spinal anesthesia" was given here as the cause of death.

CASE IV. An old man of eighty-three entered the hospital with urinary retention of one day's duration. With prostatic hyper-

trophy, myocardial fibrosis and diabetes, he remained on the Urological Service under medical supervision for eight days until, although he was considered a bad operative risk, it was considered advisable to do a suprapubic cystotomy and bilateral vasectomy. This was done under 120 mg. of novocain injected intraspinaly. The operating time was forty minutes, the blood pressure ranging from 126/80 to 140/86, and pulse averaging 140 throughout. Toward the close of the operation he complained of pain in the chest. Dressings were applied, he was placed on a carriage and wheeled into the hall on his way to the ward. He suddenly became cyanosed and died despite carbon dioxide and oxygen, cardiac and respiratory stimulation. No autopsy was held, the cause of death being given as coronary occlusion.

CASE V. A male of fifty-four, was operated upon under 20 mg. of pontocain intraspinaly with the diagnosis of intestinal obstruction, which, in the terminal ileum, was found subsequently at autopsy. The onset of his illness occurred six days prior to admission. On entering the hospital he was found to be toxic, with a blood pressure of 150/90, with his abdomen markedly distended and tympanitic throughout. There were 3 plus sugar and a trace of albumin in his urine, and a blood count showed 12,000 white cells with 92 per cent polymorphonuclears. There was some question as to whether or not he had a gangrenous appendicitis with peritonitis. Rectal examination was negative and a scout film followed by a barium enema, ruling out malignancy of the colon, confirmed the diagnosis of small gut obstruction. Considered a fair risk, though with judicious preoperative care, he was operated upon, an appendectomy with drainage being done for a gangrenous appendicitis and generalized peritonitis. The operation was completed despite respiratory collapse which occurred during the operative procedure. In the efforts to facilitate respiration, two teeth were dislodged, though recovered. In addition to this, however, the rubber cover of a tongue forceps was lost and despite laryngoscopic examination was not found. Respiratory paralysis persisted and the patient sank into deep coma. In addition to the usual measures he was placed in the respirator, never regaining consciousness, and died sixteen hours and ten

minutes after the administration of the anesthetic.

At autopsy in addition to a ruptured diverticulum of the appendix with a diffuse spreading peritonitis, an intestinal obstruction was found in the terminal ileum. There were also cardiac hypertrophy, coronary sclerosis, bronchiectasis, and cerebral congestion, and in the right main bronchus was found the foreign body. The cause of death was given as "gangrenous appendix with obstruction of terminal ileum, ruptured diverticulum of the appendix, spreading peritonitis."

This case, despite the extensive pathological disturbances and the complications incident to the efforts toward resuscitation, was doubtless a spinal anesthetic death with respiratory paralysis and cerebral anoxemia, and might perhaps have been avoided by a different technique in the administration of the anesthetic.

CASE VI. A male of fifty-six, with the onset of his illness three to four weeks before admission, entered the hospital with a diagnosis of empyema of the gallbladder and obstructive jaundice. He had had a hypertension, though his blood pressure on admission was only 140/90. Acutely ill, however, with fever, chills, a tender mass in the right upper quadrant, abdominal distention, emphysema and rales at both bases, together with a leucocytosis of 21,000, polymorphonuclears 87 per cent, and 3 plus albumin and bile in the urine, he was rightly regarded as a poor operative risk. For nine days he remained in the hospital under observation, under the conservative therapy advocated by the Medical Service. At the end of that time operation was decided upon. Twenty minutes after the injection of 18 mg. of pontocain, however, the patient went into respiratory failure and coma. Operation was withheld. He was brought back to the ward and placed in the respirator. His temperature, however, rose to 109°F. and he died four hours later.

Autopsy here revealed Laennec's cirrhosis of the liver (finely nodular), splenomegaly (portal hypertension), ascites, tracheobronchitis, myocardial hypertrophy, chronic cholecystitis with ulceration and empyema of the gallbladder. The spinal anesthetic was given

as the cause of death but surely the pathological condition was contributing.

CASE VII. This is a case of carcinoma of the head of the pancreas in a forty-year old male. A year and a half earlier he had been a patient at the hospital, with ascites, dependent edema, and dilatation of both ventricles. This, however, had cleared up and he had been discharged as a case of rheumatic heart disease with ascites of unknown cause. The onset of his last illness began three weeks before his second admission with gradually increasing jaundice. On admission his jaundice was marked, with an icteric index of 140, his liver greatly enlarged, two fingers below the umbilicus, and following a thorough work-up with preoperative preparation on the Medical Service, which included transfusion, vitamin K, bile salts, etc., he was transferred thirty-five days later to the Surgical Service for laparotomy. Pontocain was again chosen as the anesthetic agent, 20 mg. being used. The operation was begun, a carcinoma of the head of the pancreas found and cholecystojejunostomy almost finished when the patient went into respiratory failure and died forty-eight minutes after the anesthetic was given. Autopsy findings included carcinoma of the pancreas with metastasis to the periportal lymph-nodes, invasion with stenosis of the common duct, jaundice, postoperative cholecystojejunostomy (incomplete), perforation of the gallbladder (agonal?). Cause of death, "Death under anesthesia, carcinoma of the head of the pancreas."

Most of the interest in this whole question of anesthetic deaths seems usually to center only upon those patients who die under spinal anesthesia. Deaths under inhalation anesthesia attract much less attention. This is so even when the latter are elective or when the pathological state is comparatively simple and scarcely adequate in itself otherwise to cause death. In the cases under discussion as many patients had died under inhalation anesthesia as under spinal. Of the former, moreover, only one was operated upon as an emergency and in the majority the pathological status was comparatively uncomplicated. Of the seven patients dying under spinal anesthesia four were definite

emergencies, practically all were desperate cases, admittedly bad risks, and in all the pathological condition was diverse, extensive and competent in itself to result in a fatality unless corrected by successful surgical intervention. Nevertheless despite these facts, it was the spinal deaths rather than the others that had prompted the investigation and that there had actually been an appreciable number of deaths under inhalation anesthesia as well came as a complete surprise to the professional staff.

The present series of 3,193 spinal anesthetic cases covers many cholecystectomies, gastrectomies, perforated ulcers, intestinal resections, abdominoperineal resections, amputations and other major procedures. Even in such a series as this, however, the occurrence of seven fatalities is by no means to be minimized. It is not to be minimized even though the fatalities arose among patients as desperately sick as those here presented. To minimize such an occurrence is to accept what might appear to be the inevitable and to inhibit any effort to ferret out errors and to try to correct them. This investigation uncovered what we believed to be errors; it has resulted in the formulation of different standards and seems fortunately to have been followed by a lowered incidence of unfavorable results.

The question may well be asked, "Why was spinal anesthesia used at all in these seven cases and why was it preferred to general anesthesia?" The question of the choice of an anesthetic is the first one to be answered when the decision to operate on an urgent case has once been reached, and it is at all times a difficult question. The safety of the patient is, of course, the paramount consideration; but if that safety is dependent upon the successful accomplishment of a surgical procedure, the anesthetic chosen must first of all make the operation itself possible, with a minimum of surgical handicaps, and at the same time provide the maximum amount of safety commensurate with the surgical difficulties to be overcome. It must provide

this safety moreover not only during the operation itself but during the postoperative period as well, when complications attributable to the anesthetic might well vitiate the good results otherwise achieved. It is because it is the studied opinion, based on the experience of most of those on the Surgical Service at Queens General Hospital, that spinal anesthesia best meets these requirements, that it was selected in these cases, as well as in the many others in which the outcome was less tragic.

Spinal anesthesia must, however, be properly given. It must not be given by the tyro. There must be due regard to premedication, to the anesthetic agent itself, to dosage, to the position of the patient on the table at the time of injection and subsequently throughout the operation, to the desired level of anesthesia and to all the other technical points requisite to its successful employment.

Regarding premedication the methods advocated by so many writers on spinal anesthesia are usually followed, the fact being recognized, however, that over-sedation is not desirable, and in the aged or debilitated must be strictly avoided. Scopolamin, while ordinarily so valuable, is a dangerous drug in such patients and is not used. The purpose is to meet individual needs and to avoid the bad results which come from the routine use of powerful drugs.

Novocain, pontocain-glucose, and nupercain (Jones Solution—1:1500) are the anesthetic agents regularly employed. The general policy of the Surgical Service in connection with spinal anesthesia is to employ novocain as the anesthetic agent only in the more robust patients who are scheduled for lower abdominal operations of short duration. Relatively small dosage is employed in the hope of avoiding serious falls in blood pressure, even though these may be well tolerated by the type of patient for whom this agent is selected. It is practically impossible, however, when using novocain or any other isobaric solution, to limit sharply the level of anesthesia

obtained or to predict accurately what that level is likely to be. In the type of patient for whom it is employed, however, and avoiding excessive dosage, this fact is of relatively minor importance.

Pontocain-glucose and nupercain (Jones Solution—1:1500) have characteristics in their effects as spinal anesthetic agents, which sharply differentiate them from novocain. Through these effects they offer great advantages over novocain but at the same time and because of these very effects, can be counted upon to cause fatalities if improperly used. These characteristics are: (1) Their ability to produce prolonged anesthesia, and (2) their ability to flow up or down the spinal canal in accordance with the position of the patient on the operating table. Pontocain-glucose being hyperbaric or heavier than spinal fluid flows downward; nupercain (Jones Solution—1:1500), hypobaric or lighter than spinal fluid, flows upward. This fact is of vital importance, for if these drugs with their profound and prolonged anesthetic effects are allowed to invade the upper levels of the cord, disaster can scarcely be avoided.

With these facts clearly in mind, however, and with scrupulous attention to technic, sharply demarcated upper levels of anesthesia can be obtained, upper abdominal operations of considerable duration can be performed, and at the same time with the uppermost levels of the cord kept comparatively free from the anesthetic agent, extreme falls in blood pressure are largely avoided. In those patients who, because of an impaired cardiovascular status, are not able to withstand the effects of sudden and extensive falls in pressure, such an advantage is obvious.

When spinal anesthesia is indicated pontocain-glucose is the desirable agent in most upper abdominal operations. In still more prolonged operations, however, such as gastrectomies, extensive intestinal resections, or in abdominoperineal resections, or in cases requiring the Trendelen-

burg position, nupercain (Jones Solution—1:1500) is the agent of choice.

Continuous or fractional spinal anesthesia has not been taken up at Queens General Hospital although we believe that it is close to the ideal for this type of anesthesia. Dislodgment of the needle, even though slight, sometimes, however, occurs. If this takes place after a planned operation of considerable length has been begun and further injections of the anesthetic solution become impossible, one may be faced by the necessity of forfeiting altogether the advantages of spinal anesthesia in a case, too, that especially requires it.

In six of the seven cases here presented, pontocain was the drug employed as the anesthetic agent. The study of these cases, however, brought out three important points:

1. *Dosage.* No attempt was made apparently to employ minimal dosage and unnecessarily large amounts of the drug were not uncommonly used. There seems to be a tendency in "ampoule medication" to inject the entire contents of the ampoule whenever the use of its contained drug is indicated. There can be nothing but condemnation for such a practice and the employment of 20 mg. or even 18 mg. of pontocain in case after case of spinal anesthesia is an indication of the fact that those who so employ it are unaware of the possibilities which the use of lower amounts offers.

2. *Position of the Patient on the Table.* In only one case was the position of the patient on the table mentioned in the record, and in that case the position chosen was a dangerous one for the drug employed. The taking of blood pressure, the securing of hands, and the draping of patients must all wait upon the anesthetist who, after his spinal injection, is intent upon determining and controlling the level of anesthesia produced. Not until he is satisfied and the final tilting of the table completed should these measures be begun. Slight Trendelenburg position with the

head well elevated for pontocain and slight Trendelenburg position with the head down for nupercain, as minutely described by other writers, should be assured at the time of injection, and subsequent necessary and prompt changes in position should be carefully carried out in the same way.

3. *The Use of Pontocain Alone, as a Spinal Anesthetic Agent, without Admixture with Glucose.* In all of these six fatal cases under pontocain spinal anesthesia, the drug had been used alone. With all its advantages, pontocain by itself, we believe, is a dangerous drug. Isobaric, of approximately the same specific gravity as spinal fluid, its diffusion within the subthecal space cannot be predicted nor checked, and its prolonged anesthetic effect, wrongly applied, may prove disastrous. It should, we are convinced, be used only with glucose, mixed with 2 to 3 cc. of a 10 per cent glucose solution, "weighted" with it, so that when ready for injection it is a definitely hyperbaric solution. With meticulous attention to the position of the patient on the table both at the time of injection and subsequently during operation, and with proper dosage, much can then be done to limit the area of anesthesia to the level required by the operative procedure. In none of these cases had this been done, as the dangers of using pontocain or any other agent in isobaric solution were not at that time fully appreciated nor was the fact understood that by employing under the appropriate technic only definitely hyperbaric solutions such as pontocain-glucose, or definitely hypobaric solutions such as nupercain (Jones Solution—1:1500) much of this danger can be avoided.

As soon as the above facts became known through the investigation carried out by the Medical Board's committee, means were taken to stress the dangers in all types of anesthesia. The staff became "anesthesia conscious." Proper technic in spinal anesthesia was emphasized and as far as pontocain is concerned, it was never again given without admixture with

glucose. The original report of the committee had covered a period of four and a half years. It was rather encouraging to note then, that after these new regulations had been put into effect, and the report subsequently amplified so as to cover a five-year period, no further fatalities under spinal anesthesia occurred during the final six months of this period.

The statement is often made that no surgeon should give a spinal anesthetic and then proceed to operate leaving to a nurse anesthetist or someone else, perhaps inadequately trained, the responsibility of carrying his patient through the period of anesthesia. With this statement we are much in sympathy. Too, there should be no cessation in our efforts to advocate and provide for the employment only of skilled anesthetists for the administration of all types of anesthesia, putting squarely upon them the responsibility in this field which is rightfully theirs.

We cannot escape the fact, however, that to secure the services of such men in many of our hospitals, despite earnest efforts, appears at times to be practically impossible. The advantages to be derived from the use of spinal anesthesia in many difficult surgical problems, however, are such that one is scarcely willing completely to forego them, leaving to others more fortunately situated the exclusive benefits of this form of anesthesia. Until the ideal set-up can be attained, it seems fair to assume that with unremitting emphasis upon the dangers of spinal anesthesia, the need for proper selection of spinal anesthetic agents, the niceties of administrative technic and the necessity for prompt detection of danger signals as well as the energetic application of indicated therapy, that its continued use is justified and that intern staffs and residents, as well as those to whom the care of these patients is entrusted, can be so educated as to make the employment of spinal anesthesia a constantly more safe and beneficial procedure.

RECOMMENDATIONS OF THE COMMITTEE

The recommendations of the committee submitted at the close of its report are here presented:

1. Early establishment of an anesthetic department under the direction of well paid, medically trained, skilled anesthesiologists.

2. Keeping of more accurate anesthesia records.

3. More frequent medical consultations to assist in evaluating anesthetic risks.

4. Better facilities for the employment of intratracheal anesthesia.

5. Open minded recognition of the fact that among the numerous forms of anesthesia available today, whether local, rectal, intravenous, inhalation or spinal, there is a definite place for each and that there is for each anesthetic and surgical problem a form of anesthesia and a special anesthetic drug or agent which will best meet that problem.

6. More careful discrimination, therefore, in the selection of the form of anesthesia and of the anesthetic agent to be employed in the given case.

7. A wider knowledge on the part of those employing spinal anesthesia, of the uses, actions, effects, dangers and technic of administration of the various drugs or agents available, with a clear understanding of the differences between such agents as novocain, spinocain, pontocain, nupercain, etc.

8. Recognition of the fact and enforcement of the principle that it is professionally criminal for anyone to employ any spinal anesthetic agent who is not personally familiar with its use.

9. Greater discrimination, also, in the selection of spinal anesthetic agents themselves, depending upon the type and duration of the proposed operative procedure, desired position of patient during operation, general status of patient, desired level of anesthesia, etc.

10. Discontinuance of the use of isobaric solutions in spinal anesthesia except in

young patients of robust health requiring operations of short duration, and a relatively low level of anesthesia.

11. Use only of the pontocain-glucose solution when using pontocain as the spinal anesthetic agent, thus assuring a hyperbaric solution.

12. Use of nupercain (Jones Solution—1:1500) for operations of long duration or if the Trendelenburg position is desirable.

13. More careful attention to the technic of the administration of spinal anesthetics: (a) greater attention to pre-anesthetic medication; (b) intelligent determination of dosage; (c) closer attention to required position of patient on table; (d) attainment and recording of restricted levels of anesthesia; (e) appreciation of danger signals and prompt employment of indicated therapy.

14. Instruction of nurse anesthetists in the care of patients under spinal anesthesia.

SUMMARY*

1. During the five-year period from January 1, 1936, to January 1, 1941, 19,529 anesthetics, exclusive of local and intravenous anesthetics, were given at Queens General Hospital. Of these 16,273 were inhalation anesthetics, 3,193 were spinals and 63 were rectals.

2. Among these cases there were seven fatalities under inhalation anesthesia which in part, at least, were considered attributable to the anesthetic.

* During the two years that have elapsed since the completion of the period covered by the report, there has been a definite improvement in our results, as indicated herewith:

Year	Number of Spinal Anesthetics	Deaths
1941	1,023	2
1942	1,066	0

From the opening of the hospital therefore, on November 18, 1935, to January 1, 1943, the number of spinal anesthetics administered totals 5,282. There were fortunately no deaths during 1942 but the two which occurred during 1941 make nine the aggregate number of fatalities for the entire period. This is one fatality in 587 cases, or .17 per cent.

3. There were seven fatalities under spinal anesthesia, although one of these, occurring in an eighty-three year old male, after the conclusion of his operation, was thought to be due to a coronary occlusion. It is nevertheless here included as a spinal death.

4. There were four deaths under rectal anesthesia attributable, it was thought, to the anesthetic.

5. Of the seven cases under inhalation anesthesia only one was a real emergency. The others for the most part were non-urgent or elective in type.

6. Four of the seven cases under spinal anesthesia were definite emergencies and practically all were desperate cases in which both the surgical and the anesthetic risks were considerable.

7. The pathological state in the inhalation cases, with one marked exception, (peri-arteritis nodosum) was for the most part comparatively simple, whereas that in the spinal case was complicated and diverse and competent in itself to cause death.

8. The administration of pontocain in the spinal cases was considered faulty, as it was employed without the admixture of glucose, it was used in unnecessarily large doses, and proper attention was not paid to the position of the patient on the table either at the time of the spinal injection or during the subsequent operative procedure.

9. By the restricted use of isobaric solutions, the selection of hyper- or hypobaric solutions in accordance with the requirements of the case, meticulous attention to the appropriate position of the patient on the table as well as to other necessary technical points, it is believed that the dangers from spinal anesthesia can be minimized.

10. Recommendations were made to improve the anesthesia service, and to

minimize future fatalities occurring under anesthesia.

REFERENCES

1. LEMMON, W. T. and PASCHAL, G. W., JR. Continuous spinal anaesthesia, with observations on the first 500 cases. *Pennsylvania M. J.*, 44: 975-981, 1941.
2. HAND, L. V. and SISE, L. F. Anaesthesia for gastric surgery. *South Clin. North America*, 21: 803-813, 1941.
3. HAND, L. V. and SCHUHMACHER, L. F. Pontocaine-glucose solution for fractional spinal anaesthesia; preliminary report. *Labey Clin. Bull.*, 2: 167-173, 1941.
4. NICHOLSON, M. J., EVERSOLE, U. H. and HAND, L. V. Fractional spinal anaesthesia. *Am. J. Surg.*, 53: 403-411, 1941.
5. LUNDY, J. S. Choice of anaesthetic agents and methods—their relative value and recent associated advances. *Proc. Interst. Postgrad. M. A. North America*, pp. 298-301, 1941.
6. WHARTON, J. B., JR. Pontocain in spinal anaesthesia. *Tri-State M. J.*, 13: 2702-2703, 1941.
7. TUOHY, E. B. Continuous spinal anaesthesia. *Proc. Staff Meet., Mayo Clin.*, 16: 257-259, 1941; correction, 16: 320, 1941.
8. EVANS, F. T. Spinal anaesthesia with heavy percaïne (nupercaine). *Proc. Roy. Soc. Med.*, 34: 633-635, 1941.
9. SANKEY, B. B. and WHITACRE, R. J. Nupercaine and dextrose 1:1500 solution for spinal anaesthesia; preliminary report of 450 cases. *Anesthesiology*, 2: 203-204, 1941.
10. ADAMS, R. C. and LUNDY, J. S. Factors influencing choice of anaesthetic agent and some suggestions on anaesthetic technic. *South Clin. North America*, 20: 915-929, 1940.
11. NICHOLSON, M. J. Pontocaine-glucose solution for spinal anaesthesia. *South Clin. North America*, 20: 639-646, 1940.
12. NICHOLSON, M. J. Continuous spinal anaesthesia. *Labey Clin. Bull.*, 2: 34-37, 1940.
13. DINO, B. R. and MENEZ, S. C. How safe and effective is spinal anaesthesia? *J. Philippine M. A.*, 20: 411-416, 1940.
14. LAHEY, F. H. Symposium on spinal anaesthesia; introduction. *South. Clin. North America*, 20: 611-614, 1940.
15. SISE, L. F. Management of patient under spinal anaesthesia. *South. Clin. North America*, 20: 631-638, 1940.
16. HAND, L. V. Symposium on spinal anaesthesia; nupercaine anaesthesia. *South. Clin. North America*, 20: 647-652, 1940.
17. HAND, L. V. and SISE, L. F. Nupercaine anaesthesia. *Surg., Gynec. & Obst.*, 71: 9-21, 1940.
18. ANSBRO, F. PAUL and PICO, L. J. Continuous spinal anaesthesia. *Am. J. Surg.*, 55: 504-508, 1942.



SUPERNUMERARY BREASTS*

WITH SPECIAL REFERENCE TO THE PSEUDOMAMMA TYPE

CAPTAIN LEO R. WEINSHEL, M.C. AND FIRST LIEUT. NICHOLAS DEMAKOPOULOS, M.C.
MOODY FIELD, GEORGIA

CONGENITAL supernumerary breasts are not uncommon, but a supernumerary breast of the pseudomamma type, as classified by Kajava, is a relatively rare phenomenon. This belief is further substantiated by Deaver and McFarland, especially so if the supernumerary breast is found in the inguinal region, for, in reviewing over 10,000 cases of polymastia, they found only twelve cases in which this anomaly occurred in the inguinal region. It is interesting to note that a study of the literature on supernumerary breasts discloses the fact that this clinical anomaly has been overlooked somewhat by medical authors, and that detailed descriptions or accurate case records are difficult to find. It may be that what is written in this paper may be repetitious, but it is hoped that those of the medical profession who have seen supernumerary breasts of the pseudomamma type in the past will be stimulated to the point of submitting cases, photographs, and other pertinent data.

EMBRYOLOGY

Traced from its embryonal origin, the human breast arises from an epidermal ridge or primitive "milk line," which extends between the upper and lower limb buds on either side of the midline. In the second month of intrauterine life, breast anlage appear. These breast anlage appear in the embryos of all mammals, to be developed or suppressed according to phylogenesis. In man the anlage appear in the form of an evagination on each side in the pectoral region at the site of the normal breast, and the remaining anlage are suppressed and disappear. When suppression of any of the rudimentary anlage fails, and

when the so-called "milk spots" develop unduly, supernumerary breasts appear at different points along the course of the epidermal ridge.

Although there are no records to aid and enlighten us in the study of the historical aspects of the subject, certain conclusions may be surmised from the facts that the Phoenician goddess, Astarte, was frequently portrayed as having an accessory number of mammary glands, and that the well known goddess Diana was usually represented with her trunk covered with large and well formed mammae.

Geoffroy-Saint Hilaire, in 1836, suggested that man was descended from animals having multiple breasts. Darwin (1871) in his "Descent of Man" called attention to the fact that supernumerary breasts should be considered an atavistic manifestation. Champney believes that supernumerary mammary glands are enlarged sweat glands and not true breasts, a theory which was supported by Tandlaus' observation of a patient in whom there was complete failure of development of the breast and nipple, together with total absence of sweat glands all over the body and partial absence of the sebaceous glands.

CLASSIFICATION

Complete supernumerary breasts are exceptional. Usually supernumerary breasts appear as polythelia or pseudomamma. Kajava classified congenital supernumerary breasts as shown in Table 1.

INCIDENCE AND LOCATION

Supernumerary mammary glands, or polymastia, and supernumerary nipples, or polythelia, are said to occur rather more

* From the Surgical Service of the Station Hospital, Moody Field, Georgia.

frequently in the male than in the female. De Cholnoky, in 1939, in an excellent review of the literature on supernumerary breasts, reported that one additional breast

TABLE I
KAJAVA'S CLASSIFICATION OF SUPERNUMERARY BREASTS

Type of Breast	Nipple	Areola	Gland Tissue	Fat Tissue
Complete	Present	Present	Present	Present
Supernumerary	Present	None	Present	Present
Supernumerary	None	Present	Present	Present
Aberant	None	None	Present	Present
Pseudomamma	Present	Present	None	Present
Polythelia	Present	None	None	None
Polythelia areolis	None	Present	None	None
Polythelia pilosa	Only a patch of hair is present			

occurs in from 60 to 65 per cent of the cases, two in 30 to 35 per cent, three in 3.5 to 4 per cent, and four in 1.5 to 2 per cent. It seems, therefore, that the relative incidence of supernumerary breasts diminishes with the increase in the number of those organs observed in one person.

In general, more accessory mammae are noted on the left side of the body than on the right, and a great many more are observed below the normal breasts than above them. Those situated below the normal breast are usually medial to the normal breast, whereas those above the normal site are usually found lateral to the normal breast region. However, cases have been reported in which supernumerary breasts have occurred on the cheek, neck, ear, tragus and helix, upper part of left arm, thorax and abdomen, shoulder, back, lumbar region, pubic and inguinal regions, flank and hip, thigh and Scarpa's triangle, thigh and dorsolateral aspect, buttock, vulva, labia majus and minus. Supernumerary breasts located in these atypical regions are said to be rare and usually asymmetrical when they do occur. In most cases, these abnormal organs are very rudimentary and suppressed in their development, and are often represented by a minute nipple or pigmented areola.

Deaver and McFarland compiled a series of cases of atypical locations of super-

numerary breasts, and among those noted were twelve cases of pubic and inguinal accessory mammae. Four of these cases occurred in males, six in females, and two in sex unknown. It was our fortune to see a case of an extremely large supernumerary breast of the pseudomamma type located in the left inguinal region of an otherwise normal, colored, adult male. In reviewing the literature, we found such little mention of this type of congenital anomaly that we are reporting this case at this time, together with those cases of Deaver and McFarland in which supernumerary breasts occurred in the inguinal region of the male.

CASE REPORTS (DEAVER AND MCFARLAND)

1. Steinborn and Mosig. *Münch. med. Wchnschr.* Vol. 471, 1900. The subject was a man forty-seven years old. In Scarpa's triangle on the inner aspect of the left thigh there is a hemispherical enlargement like the mammary gland of a virgin, about puberty, surmounted by a well formed but long nipple surrounded by a dark areola in which grew a number of dark hairs. There was no secretion.

2. Knox. Reported from Dr. D. N. Knox's notes by Dr. Wm. Sneddon, Glasgow Medical Journal, 1879, n. s., xi, 92. The patient, a full-grown man, came to consult about a tumor in his groin which he said had always been there but which had, of late, been growing rather larger, and had given him both bodily and mental uneasiness. On examining the tumor it proved to be an extra mamma with well formed nipple situated upon the inner side of the right thigh close below the external inguinal ring. It was about 2 inches long and 1½ inches broad, but was evidently tumified at the time I saw it, probably from some irritation.

3. Dietschy. *Correspondenzbl. f. schweiz. Aerzte, Basle*, 43: 366, 1913. The subject was a man twenty years of age suffering from pulmonary tuberculosis. On the inner side of the left thigh, 12 cm. from the upper border of the symphysis pubis there is a typical little mammary gland. It is somewhat oval in shape and is surrounded by an areola 12 cm. long and 0.8 cm. broad. The papilla is 0.4 cm. in diameter and its height 0.2 cm. It was a little smaller by actual measurement than his left pectoral mamma and more deeply pigmented. It also

has a few dark hairs which the pectoral mamma lacks.

4. *Hoepfner*. Inaugural Dissertation, Jena, 1899. The subject was a man of about thirty

he was subjected frequently to ridicule and embarrassment whenever he exposed his body in the soldiers' barracks while dressing and bathing. The patient does not recall just how



FIG. 1. Lateral view showing nipple, areola and gland.



FIG. 2. Tangential view of supernumerary breast, left inguinal region.

years. He had a supernumerary mammary gland upon the inner aspect of the left thigh 11 cm. below the symphysis pubis. It appeared as a darkly pigmented wart.

5. *Romiti*. *Anatomia dell'Uomo*, Vol. 11. Is said by Fiori (*Bull. d. r. Acad. Med. di Genova*, 20: 369, 1905, to have described a mammary gland in Searpa's triangle.

6. *Sacasa, Roberto*. (Thèse de Paris, 1867.) This report says that in 1863 a man appeared in Velpeau's clinic with a mamma-like formation surmounted by a kind of nipple, in the upper inner aspect of the left thigh. The great surgeon called it a lipoma, and discussed its resemblance to a mammary gland. The man refused to be operated upon, so the true nature of the enlargement is not known.

Since there are so few cases of supernumerary breasts in the inguinal region of the male reported in the literature, it therefore appears warranted to add another case in detail.

A. M., a twenty-eight year old colored male, Case No. 531, entered the surgical service of the station hospital on April 13, 1942, because of a tumor mass of the left inguinal region which had been present for many years.

His primary reason for seeking hospitalization was that this tumor mass resembled a normal, adult, female breast, fully developed with nipple and areola, and because of this,

long he had this anomaly, but he believed that it came on at puberty and it had not changed in size or shape for the past six years. There had never been any discharge from the nipple, pain, or any other abnormal symptom referable to the tumor mass.

The past history was noneontributory, in that he had only the usual childhood diseases, and no injuries or surgical operations. There was no familial history of supernumerary breasts or other congenital anomalies. The family history was negative for organic disease and the history by systems was likewise essentially negative.

Physical examination revealed a colored male, age twenty-eight, who was normal in all respects except for the presence of a large accessory breast in the left inguinal region, inferior to Poupart's ligament and lying between the anterior superior iliac spine and the pubic tubercle. (Figs. 1 and 2.) This accessory breast resembled a normal, fully developed, female breast, with a normally developed nipple and areola. The nipple was directly in the line of the embryonal milk ridge. The breast tissue felt firmer than female breast tissue, but other than that, it grossly resembled a normal female breast in all respects. Measurements were noted as follows: Length, 12.7 cm.; width, 7.6 cm.; height, 4.5 cm. The areola measured 3.2 cm. in diameter.

The urinalysis, serology, and the complete blood counts were essentially negative. A

roentgenological examination of the tumor mass revealed that the mass contained no calcified bodies and was not attached to any underlying bony framework. (Fig. 3.)

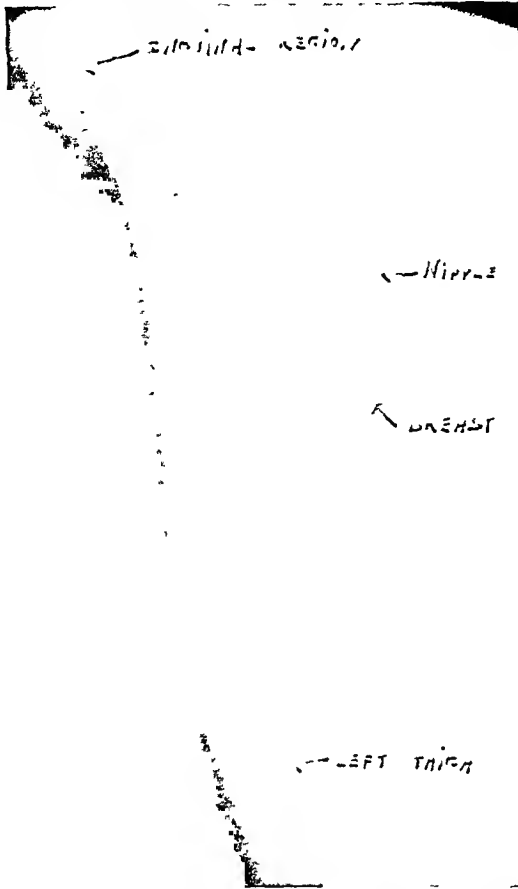


FIG. 3. Photograph of roentgenogram outlining soft tissue structure.

A diagnosis of supernumerary breast of the left inguinal region, congenital in origin, was made.

On April 15, 1942, the patient was taken to surgery, and under local infiltration with 1 per cent procaine hydrochloride, a simple mastectomy was performed. The patient had an uneventful postoperative course and was discharged from the hospital on May 4, 1942. (Fig. 4.)

The specimen was forwarded to Lawson General Hospital, Atlanta, Georgia for pathological examination. The gross examination revealed a specimen consisting of a piece of skin 10 by 6 cm., with an elevated nodule resembling a nipple, 1.5 cm. in height and 3 cm. in diameter at its base, covering 150 Gm. of yellowish lobulated tissue. Microscopic examination revealed benign fatty tissue with

no evidence of breast tissue. Sections through the nodule resembling a nipple revealed no evidence of ductal elements. A diagnosis of benign lipoma was made.

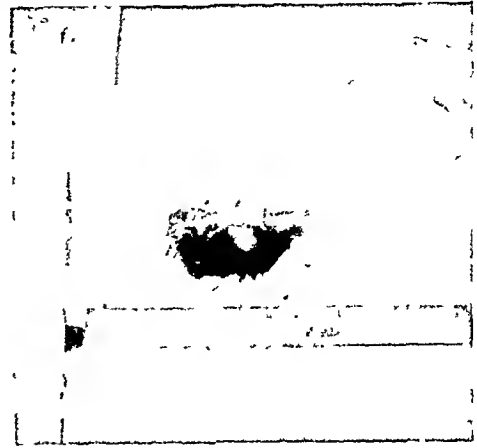


FIG. 4. Gross specimen.

DIFFERENTIAL DIAGNOSIS

This case, in our opinion, is truly a case of congenital supernumerary breast, pseudomammatous in type as given by Kajava. (Table 1.) We have here a normal colored male who at the age of puberty developed this abnormal breast. Grossly it resembled a female breast having a fully developed nipple, areola, and what appeared to be glandular tissue on palpation, except for a somewhat firmer consistency. Only the microscopic examination revealed the true condition, namely, a replacement of the glandular tissue by fatty tissue. According to De Cholnoky, supernumerary breasts are frequently diagnosed as lipomas, for in four of his eleven cases clinically diagnosed as lipomas, microscopical examination established the presence of breast tissue. Thus, one can make, clinically, an undifferentiated diagnosis of supernumerary breast without regard to its specificity. It remains for the pathologist to determine the presence or absence of glandular tissue. Deaver and McFarland stated that in men having supernumerary breasts, unless microscopic examination was made, it would be impossible to determine whether supernumerary breasts have glandular tissue or not; whereas in women the presence of glandular tissue can be determined with

certainty if the subject becomes pregnant and lactates.

Accessory mammae are also to be differentiated from hypertrophied sudariparous and sebaceous glands, lymphadenitis, chronic lymphadenopathy caused by syphilis, tuberculosis, Hodgkin's disease, lymphosarcoma, or metastatic carcinoma.

TREATMENT

The harmless existence of the supernumerary breast requires no medical or surgical treatment. It is only when the accessory breast has an abnormal discharge or location that surgical removal may be requested by the patient. In our case, the unusual size of the breast and its resemblance to a normal female breast caused him no end of embarrassment and shame. Thus, for cosmetic and psychological reasons it was deemed best to remove the breast.

The operation itself is usually a simple procedure, and recovery is rapid and uneventful. The patient goes on to lead a full and happy life, satisfied with the knowledge that he or she is the equal of all other men or women.

CONCLUSIONS

Polymastia is a common congenital malformation of which the literature shows the reported occurrence of upward of 10,000 cases, but the development of a supernumerary breast in the left inguinal region in the male is a very rare phenomenon.

The embryology, classification, incidence, location, differential diagnosis, and treatment of supernumerary breasts are discussed.

There are definite indications for surgical intervention in polymastism and they are as follows: painful or disfiguring supernumerary breasts, and the presence of a malignancy in these aberrant glands.

A case is reported, wherein a supernumerary breast, pseudomamma type, was removed from the left inguinal region of a colored, adult male. Insofar as we have been able to ascertain by a review of the literature, this reported case constitutes

the fifth case of reported supernumerary breasts in the inguinal region of the male.

The authors are indebted to Major Charles A. Pigford, M.C., Commanding Officer of the Station Hospital, Moody Field, Valdosta, Georgia; Captain Arthur A. Nadler, M.C., Executive Officer, and Mr. John Bridges, Roentgenological Technician, for their technical assistance in the preparation of this manuscript.

REFERENCES

- BIRKENFELD, W. Beitrag zur Zwillingspathologie der Mamma. *Arch. f. klin. Chir.*, 168: 568, 1932.
- CHAMPNEYS, F. H. On the development of mammary function by the skin of lying-in women. *Med.-Chir. Tr.*, London, 69: 419, 1886.
- DEAVER, J. B. and MCFARLAND, J. The Breast: Its Anomalies, Its Disease and Their Treatment. London, 1918. William Heineman.
- DE CHOLNOKY, TIBOR. Supernumerary breast. *Arch. Surg.*, 39: 926, 1939.
- FORSTER, A. Ein Fall uberrah-liger rudimentarer Mammabildung an der Innenseite des Obersehenkels eines Mannes. *Anat. Anz.*, 49: 529, 1917.
- GEOFFROY-SAINT-HILAIRE, I. Histoire générale et particulière des anomalies de l'organisation chez l'homme et les animaux. Paris, 1: 710, 1832-1836. J. B. Bailliere.
- GILL, W. D. Polymastism in woman. *South. M. J.*, 20: 10, 1927.
- GREENE, H. J. Adenocarcinoma of supernumerary breasts of the labia majora in a case of epidermoid carcinoma of the vulva. *Am. J. Obst. & Gynec.*, 31: 660, 1936.
- HANSEMAN, W. Polymastie. *Verhandl. d. Berliner Anthropol. Gesellsch.*, 21: 434, 1898.
- HENNIG. Über mensliche Polymastie und über Uterus bicornis. *Arch. f. Anthropol.*, 19: 185, 1891.
- KAJAVA, Y. The proportion of supernumerary nipples in the Finnish population. *Duodecim*, 31: 143, 1915.
- KLINKERFUSS, G. H. Four generations of polymastia. *J. A. M. A.*, 82: 1247, 1924.
- MALINIAC, J. W. Breast deformities, anatomical and physiological considerations in plastic repair. *Am. J. Surg.*, 39: 54, 1938.
- MALINIAC, J. W. Asymmetrical breast deformities. *Ann. Surg.*, 99: 743, 1934.
- MASON, L. W. Polymastia. *Colorado Med.*, 31: 141, 1934.
- MCFARLAND, J. Case of mammary gland tissue in the axilla. *Am. J. Path.*, 5: 23, 1929.
- MCFARLAND, J. Mammary gland situated on labium majus: report of case. *Arch. Path.*, 11: 236, 1931.
- MOURADIAN, A. H. Bilateral lactating supernumerary mammary glands. *Med. Rec.*, pp. 113-114, 1935.
- NORONHA, A. J. Cystic disease in supernumerary breasts. *Brit. J. Surg.*, 24: 143, 1936.
- PANKOW, L. J. Accessory extra, supernumerary multiple breasts: case report. *Lancet*, 49: 539, 1929.
- RIBEIRO, E. B. Sobre mamma supranumeraria. *Bol. Soc. de med. e cir. de São Paulo*, 15: 333, 1931.
- STOREY, C. F. Polymastia, with special reference to supernumerary axillary breasts: brief review with case report. *U. S. N. Med. Bull.*, 34: 362, 1936.
- WHITE, R. J. Fibroadenoma in an accessory breast. *Am. J. Surg.*, 8: 830, 1930.

LITTRÉ'S UMBILICAL HERNIA†

CASE REPORT

W. EDWIN BIRD, M.D.

Attending Surgeon, Wilmington General Hospital; Editor, Delaware State Medical Journal

WILMINGTON, DELAWARE

TWO years ago the author reported on the subject of "Right Paraduodenal Hernia," adding the forty-seventh case to the literature of that subject. A few months ago we encountered a case that presented an unusual and perhaps unique picture of one variety of the condition known as Littré's hernia.

In 1700, Alexis Littré recorded two cases of inguinal hernia in which an intestinal diverticulum or pouch of some sort was the sole occupant of the sac. The possibility of this condition had been suggested first following an autopsy in 1683 by Frederik Ruysch, a famous Dutch anatomist and atlas maker. Littré described these pouches as secondary formations; he thought they resulted from traction on the part of the gut within the sac and hence regarded them as partial enteroceles. Lesions of this latter type were accurately described in 1777 by August Gottlieb Richter in a treatise on hernia which is still an acknowledged classic, and this type of hernia—partial herniation of the antimesenteric portion of the gut—is today still catalogued as a Richter's hernia though it had been observed earlier (1772) by Johann Casper Lavater.

In 1809, Johann Friedrich Meckel* was the first to classify the different varieties of intestinal diverticula. The most impor-

tant of these and the one to which his name has been given, is that which represents an incomplete obliteration of the omphalomesenteric or vitelline duct. With this diverticulum situation clarified, a review showed that the lesion which Littré had described over a century before was a Meckel's diverticulum alone in a hernial sac. Riecke, having observed a strangulated femoral hernia of Meckel's diverticulum in 1834, was the first in 1841 to suggest calling them Littré's hernias.

Considerable confusion exists in the literature over these three clinical entities: (1) Richter's hernia—a partial enterocoele; (2) Littré's hernia—a hernia of Meckel's diverticulum alone, and rarer than (3); and (3) mixed Meckel's hernia—a hernia of Meckel's diverticulum, plus gut or omentum, or both.

Just why Littré's should be rarer than Meckel's nobody has explained. Perhaps it is due to the fact that a diverticulum has no propulsive or expansive characteristics, whereas gut and omentum have both. The chances are the gut or omentum arrived in the sac first and the diverticulum followed, not by adhesive but by cohesive traction.

Speaking of confusion, Moschowitz, in Johnson's "Operative Therapeutics" (1915), clearly distinguishes between a Richter's

* This Meckel, according to Garrison, came of a famous medical family. His grandfather, of the same name, graduated from Goettingen in 1748, at the age of twenty-four, his thesis being on the (Meckel's) sphenopalatine ganglion of the fifth cranial nerve. Three years later he was Professor of Anatomy, Botany and Obstetrics (*sic!*) at Basle. His father, Philipp Friedrich Theodor Meckel, graduated from Strassburg in 1777, at the age of twenty-one, his thesis being on the inner

ear, and two years later he was Professor of Anatomy and Surgery at Halle. His brother, August Albrecht Meckel, at thirty-one, became Professor of Anatomy and Forensic Medicine at Bern. Our Meckel became Professor of Pathology, Comparative Anatomy and Embryology at Halle. Thus this family, in three generations, produced four professors, all before they had passed their thirty-first year.

† Read before the 152nd Annual Session of the Medical Society of Delaware, Wilmington, October 7, 1941.

hernia and a Littre's hernia; whereas Stone, in Lewis' "Surgery" (1929), shows an illustration labelled "Littre's or Richter's Hernia" (which is definitely a Richter's hernia), and he repeats the statement in the text. It is unfortunate that such a popular reference work carries the implication that a Littre's hernia and a Richter's hernia are one and the same thing.

As to Littre's hernia, Babcock defines it as "a sac containing a blind diverticulum only, such as Meckel's diverticulum or the appendix vermiformis," whereas the blind diverticulum that Littre described was a vitelline duct vestige and not the appendix, though this is another vestigial organ. Keeley states that the sac may also contain "small or large intestine, and/or omentum," and Watson, an acknowledged authority on hernia, says it "may be accompanied by small intestine . . . or omentum alone," a statement reiterated by DaCosta. However, Weinstein's recent paper (December, 1938) on Littre's femoral hernia brings us back again to the original basis when he says "that the title of Littre's hernia is applied only if the diverticulum is of Meckel's type, and is the sole occupant of the hernial sac."

It is not our purpose here to go into lengthy descriptive details concerning Meckel's diverticulum as Goodman's excellent article covers the ground thoroughly. Suffice it to say that normally the vitelline duct begins to atrophy at the seventh week of fetal life, is completely obliterated by the twelfth week, and at birth no remnant is visible. Failing to perform according to schedule, there may be present at birth anything from a mere nubbin of a closed pouch (generally on the antimesenteric border of the gut, generally without a mesentery, and at a point 12 to 36 inches from the ileocecal valve) to a continuous open tube extending from the ileum to the umbilicus and discharging feces. Consequently, the shape and size, and the mobility or fixation of Meckel's diverticulum varies within quite large limits.

A Meckel's diverticulum is subject to

all the lesions that obtain in other parts of the gut; inflammation, ulcer, hemorrhage, foreign body, tumor, obstruction, strangulation, gangrene, torsion or volvulus, intussusception (in approximately 25 per cent of the reported cases), and herniation (in another 25 per cent). Herniation of the mixed Meckel's type or of the true Littre's type is possible at any of the sites of external herniation of the abdomen, and the following varieties have been reported: inguinal, femoral, umbilical, ventral (incisional), crural and sciatic. We could find no record of any case of the following types: spontaneous ventral, diaphragmatic, obturator or lumbar. Of the many possible types of internal herniation only one case has been recorded, a retrocecal hernia.

Littre's own description of his cases can, after more than 200 years, be read today without modification other than the knowledge that he was describing a hernia of Meckel's diverticulum and not, as he supposed, of what is now termed a Richter's hernia. Witness his accurate remarks on the diagnostic features, as given by Mason:

"The diagnostic signs, making this type of hernia recognizable before the operation, are:

"1. The patient goes to stool during the whole course of the illness as, the intestinal canal being uninterrupted, the excrements are at perfect liberty to pass from one end to the other.

"2. The patient has no hiccough, or very occasionally.

"3. He does not vomit, at least by comparison less frequently than in ordinary herniae. The vomitus is never fecal matter.

"4. The patient's belly is never fat, stretched or full of wind as in ordinary herniae.

"5. The tumor in the groin is formed more slowly and never becomes so large.

"6. The inflammation, fever, pain or other symptoms which may accompany this peculiar kind of hernia, are less severe and take longer to manifest themselves than in other herniae.

"The diagnostic signs which make this particular hernia recognizable during the operation are:

"1. In ordinary cases of hernia, the entire circumference of the intestinal body is engaged in the hernial sac. In this hernia there is only one part in the sac.

"2. The portion of the intestine which forms an ordinary hernia is found doubled in the shape of an arc in the sac. In this particular kind (which concerns us), this portion is single, situated perpendicularly and terminated by a very distinct end.

"3. An ordinary hernia is often formed by intestine and omentum together. This particular kind is always made by the intestine alone."

Operation on an uncomplicated Meckel's diverticulum has a mortality rate slightly above that of appendectomy, i.e., 3 to 5 per cent. If the diverticulum is diseased but not herniated, the rate runs as high as 35 to 40 per cent. If the diverticulum is diseased and is herniated, the operative mortality extends from 45 to 50 per cent.

In diverticular hernia, the inguinal variety is commonest, being two and one-half times as frequent as the femoral or the umbilical types. Following the rule in simple hernia, in the femoral variety females outnumber the males 3 to 1; whereas in the inguinal variety exactly the reverse is true. In both of these the majority are on the right side, and most of the cases are in adults and the middle-aged. (Parenthetically, we might add that Richter's hernia is commonest in the femoral region.) In the umbilical variety sex is stated so infrequently that no reliable figures are available. Age, however, is definitely a factor, over 85 per cent being found in the newborn or in very young infants.

There is a marked discrepancy between the anatomical and the surgical occurrence of Meckel's diverticulum, due to the fact that the pathologist explores the entire abdomen, while the surgeon usually explores only a limited area of the abdomen. Anatomically, Meckel's diverticulum is found in $1\frac{1}{2}$ to 2 per cent of humans, accord-

ing to various postmortem observations. The surgical incidence seems to be considerably less, about one-tenth, and varies from one case in 700 laparotomies at the Mayo Clinic, to one case in 450 at the Vanderbilt University Hospital, to one case in 400 at the New York Post-Graduate Hospital, an average of one case in 500 laparotomies. Further, Forgue and Riche, in 1907, analysing 600 cases of Meckel's diverticulum, found that fifty-two (8.7 per cent) or about one in twelve occurred in hernias. On this basis one might anticipate encountering some type of Meckel's hernia once in 6,000 laparotomies. Finally, our own tabulation shows that 20 per cent of Meckel's hernias are umbilical, and at this rate one might anticipate encountering a Meckel's umbilical hernia once in 30,000 laparotomies, surely an astronomical expectancy. True Littre's hernias are even rarer.

TABLE I
REPORTED CASES OF MECKEL'S DIVERTICULUM IN A
HERNIA
Summary

Type	Gray, 1934	Bird, 1941	Total	Per Cent
Inguinal.....	89	6	95	52.19
Femoral.....	33	4	37	20.33
Umbilical.....	37	1	38	20.88
Ventral (incisional).....	0	1	1	0.55
Crural.....	0	1	1	0.55
Sciatic.....	1	0	1	0.55
Retrocecal.....	1	0	1	0.55
Not stated.....	8	0	8	4.40
Total.....	169	13	182	100.00

Simple congenital umbilical hernia is rare enough, and occurs about once in every 10,000 births. Such a hernia, containing a diverticulum, is considerably rarer. The number of cases of Meckel's diverticulum in a hernia, tabulated up to February 1934 by Gray, was 169, of which only thirty-seven were of the umbilical variety. To this 169 we have been able to add twelve non-umbilical cases, and our present umbilical case, the first since 1928, and which makes

the thirty-eighth case to be reported. Several of the cases tabulated were of the mixed Meckel's type. We have not yet

vises the feedings, etc. On the fourth day the cord sloughed off (Fig. 2), and later that day some feces were passed via the umbilicus. On

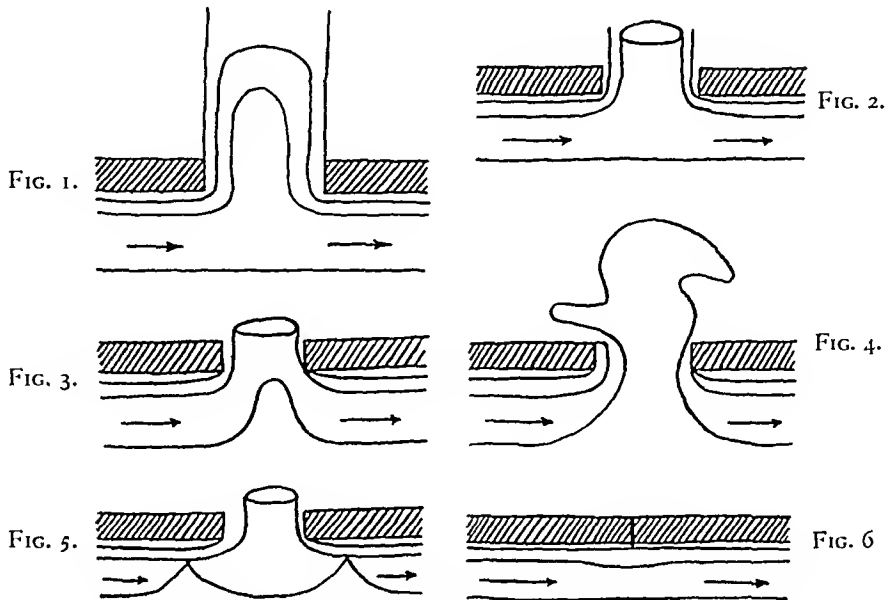


FIG. 1. The anatomy at birth, showing an apparently normal cord but containing an unsuspected hernia sac into which protrudes a Meckel's diverticulum.

FIG. 2. Fourth day, showing the cord, hernia sac and the diverticulum sloughed off at the point of ligation.

FIG. 3. Fifth day, showing the beginning of the eversion of the mesenteric border of the gut through the opening in the diverticulum.

FIG. 4. Seventh day, showing the eversion completed and the main pouch with its two secondary pouches. The presenting surface was, of course, mucosa. At operation, on the twenty-fourth day, the two lateral openings, mistaken for fistulas, were sutured.

FIG. 5. At operation after the eversion was reduced it was discovered that the two sutured "fistulas" had been converted into two complete obstructions. The eversion was then re-established, as in Figure 4 and the offending sutures removed.

FIG. 6. The operation completed, showing the lumen of the gut approximately normal in diameter.

been able to determine the exact number of true Littré's hernia on record.

CASE REPORT

The patient was a male, colored baby, born of an eighteen year old unmarried mother, para II, on March 17, 1941, at the Wilmington General Hospital. The baby weighed 6 pounds 12½ ounces, and appeared to be physically normal in all respects. There was no apparent enlargement (Fig. 1) of the umbilical end of the cord which was tied off in the usual manner. On the third day the cord was red and had a slight purulent discharge, and on this day the Pediatric Department was called in to super-

the fifth day a loop of gut or a pouch began to present at the umbilicus (Fig. 3), and by the sixth day this extended 3½ inches on to the abdominal wall.

On the seventh day the Surgical Department was called in consultation. The weight was then 5 pounds 15 ounces. Our examination showed a pouch of intestine on the abdominal wall (Fig. 4) some 5 inches long and 2½ inches in diameter with a blind end. From the right side of this pouch was a secondary pouch, arising 1½ inches from the umbilicus with a diameter of ½ inch, and extending 2 inches to end blindly. From the left side near the distal end of the main pouch was another

secondary pouch nearly 1 inch in diameter and extending 2 inches to end blindly. The extra-abdominal portion of the sac (peritoneum) was missing. On palpation the pouch and the absence of symptoms of obstruction; as a matter of fact, stools were also passed through the rectum daily both before and after operation.

TABLE II
REPORTED CASES OF MECKEL'S DIVERTICULUM IN A HERNIA
Tabulation

Re- port No.	Author	Date	Cases	Inguinal	Femoral	Umbilical	Ventral (Incisional)	Cruial	Sciatic	Retrocecal	Not Stated
1	Pabst	1910	123	66	24	25	0	0	0	1	7
2	Wellington	1913	27	14	2	10	0	0	0	0	1
3	Burianek	1913	1	0	1	0	0	0	0	0	0
4	Harf	1919	1	0	1	0	0	0	0	0	0
5	Quenu	1921	1	1	0	0	0	0	0	0	0
6	Bettman	1921	1	1	0	0	0	0	0	0	0
7	Ludbrook	1922	1	0	1	0	0	0	0	0	0
8	Brodnax	1924	1	0	0	0	0	0	1	0	0
9	Lanman	1924	1	1	0	0	0	0	0	0	0
10	Littler	1924	1	0	1	0	0	0	0	0	0
11	Harrington	1926	1	0	1	0	0	0	0	0	0
12	Bianchi	1927	2	1	0	1	0	0	0	0	0
13	Oliva	1927	1	1	0	0	0	0	0	0	0
14	Sicard	1928	1	0	0	1	0	0	0	0	0
15	Reid	1928	1	1	0	0	0	0	0	0	0
16	Pollidori	1930	2	2	0	0	0	0	0	0	0
17	Sweet	1930	1	0	1	0	0	0	0	0	0
18	Donati	1931	1	0	1	0	0	0	0	0	0
19	Gray	1934	1	1	0	0	0	0	0	0	0
20	Sinclair	1922	1	0	1	0	0	0	0	0	0
21	Folliasson	1932	1	1	0	0	0	0	0	0	0
22	Mason	1933	1	0	1	0	0	0	0	0	0
23	Ittzes	1934	1	1	0	0	0	0	0	0	0
24	Bettinelli	1935	1	1	0	0	0	0	0	0	0
25	May	1935	1	1	0	0	0	0	0	0	0
26	Rodnaev	1936	1	1	0	0	0	0	0	0	0
27	deTroyer et duBourguet	1937	1	1	0	0	0	0	0	0	0
28	Kecley	1937	1	0	0	0	1	0	0	0	0
29	Quiri	1938	1	0	0	0	0	1	0	0	0
30	Weinstein	1938	1	0	1	0	0	0	0	0	0
31	Ringo & Charlton	1940	1	0	1	0	0	0	0	0	0
32	Bird	1941	1	0	0	1	0	0	0	0	0
Total			182	95	37	38	1	1	1	1	8
Per cent			100	52 19	20 33	20 88	0.55	0.55	0.55	0 55	4 40

Tabulation of Reports Nos. 1 to 19 after Gray; Nos. 20 to 32 by the author.
No. 20, Sinclair's case, contained also a Richter's hernia, the only combined case in the literature.

felt as though it contained omentum; there were no gurgles. The neck of the pouch was adherent to the umbilical ring, which was 3/4 inch in diameter, and from the left side of the ring feces were passing through a small opening. The main pouch could not be reduced because of edema and the adhesions, nor could it be pulled out further. The flow of feces accounted for the progressive loss of weight

The surface of this trilocular pouch appeared to be mucosa but a differentiation between mucosa and peritoneum with massive granulations could not surely be made. However, a tentative diagnosis was made as follows: congenital umbilical hernia, sac contents either cecum and appendix or Meckel's diverticulum; fecal fistula. Operation was advised and accepted by the family. In consultation with the

pediatrician it was decided to wait a few days in an effort to build up the patient. Unfortunately, the baby lost ground steadily and on

seemed to enter the ring from within. The left external opening through which feces were still passing was then sutured as was a similar



FIG. 7. The patient in the recumbent position.

the twenty-fourth day the weight was only 4 pounds $13\frac{1}{4}$ ounces, a loss of one-third of the birth weight, and operation was decided upon as a matter of necessity.



FIG. 8. The patient in the upright position.

On April 10, 1941 under novocain anesthesia the abdomen was opened below the umbilicus where nothing was noted. On enlarging the incision up to the umbilicus two loops of ileum

opening on the right side, following which the neck of the pouch was freed of its adhesions to the ring. Then on pushing the main pouch back into the abdominal cavity it suddenly turned outside in, and it was apparent that it had been the mesenteric side of a Meckel's diverticulum completely everted by passing through the opening made by the sloughing off of the top of the cord and of the parietal peritoneum. On passing a soft catheter proximally and distally it was found that the two sutures we had placed had very neatly closed (Fig. 5) the lumen at both points. The eversion was then re-established, the two sutures removed and the pouch inverted once more.

The picture then was that of a Meckel's diverticulum with a base of $1\frac{1}{2}$ inches and a height of $\frac{3}{4}$ inch to the opening made by the sloughing. How much greater the original height had been is a matter of conjecture, probably another $\frac{3}{4}$ inch. The remaining part of the diverticulum was then excised, the ileum sutured longitudinally with two rows of fine silk, leaving a lumen of approximately normal diameter. The diverticulum was 12 inches from the ileocecal valve. The umbilicus was then excised and the hernia repaired quickly by longitudinal suturing (silk, Pagenstecher, dermal) without drainage (Fig. 6). Just before closing the peritoneum 150 cc. of Ochsner's papain solution was run into the abdomen as a protection against colon bacillus infection. For the final stages of the closure a few whiffs of vinethane were given. The patient was returned to the ward in fairly good condition.

The pathological report stated that the diverticulum contained no gastric, duodenal, pancreatic or other heterotopic tissue.

Postoperatively, the baby did fairly well for three days, gaining 5 ounces in weight. On the fourth day it developed a pneumonia in the left lower lobe and succumbed on the sixth day at the age of thirty days. The autopsy, in addition to the left pneumonia, showed a beginning pneumonia in the right lower lobe. There was a moderate degree of plastic peritonitis at the operative site, which probably represented an infantile reaction to the papain in solution, the adhesions of which were easily separated. Also, the liver showed extensive fatty degeneration.

SUMMARY

1. Meckel's diverticulum in a hernia is discussed and the recorded (182) cases tabulated to date.

2. Littré's hernia is differentiated from the lesions with which it is confused.

3. A new case of the umbilical variety of Littré's hernia is reported, and its operative rarity estimated.

4. The case presented, the thirty-eighth in the literature, is perhaps unique.

CONCLUSIONS

1. Hernia of the umbilical cord is so rare that its possible presence is usually not suspected at delivery.

2. The sequelae of such an unsuspected hernia may be fatal.

In the absence at birth of physical findings indicating such an anomaly, there is no sure or even satisfactory method of preventing an accident.

REFERENCES

- BABCOCK, W. WAYNE. Textbook of Surgery. 1st ed., p. 1167. Philadelphia, 1928. W. B. Saunders Co.
- BETTINELLI, O. Strangulated inguinal hernia containing Meckel's diverticulum. *Policlinico*, 42: 1396, 1935.
- BIRD, W. EDWIN. Right paraduodenal hernia. *Delaware State M. J.*, 12: 231, 1940.
- DACOSTA, JOHN C. Modern Surgery. 10th ed., p. 1087. Philadelphia, 1931. W. B. Saunders Co.
- DETROYER, PERRIGNON et DUBOURGUET. Strangulation of Meckel's diverticulum filled with foreign bodies in congenital inguinal hernia. *Mém. Acad. de chir.*, 63: 681, 1937.
- FOLLIASSON, A. Hernie du diverticule de Meckel. *Bull. Soc. de pédiat. de Paris*, 30: 487, 1932.
- FORGUE, E. and RICHE, V. Le Diverticule de Meckel. Paris, 1907. O. Doin.
- GARRISON, FIELDING H. An Introduction to the History of Medicine. 4th ed. Philadelphia, 1929. W. B. Saunders Co.
- GOODMAN, B. A. Meckel's diverticulum. *Arch. Surg.*, 36: 144, 1938.
- GRAY, HOWARD K. Meckel's diverticulum in a hernia. *Minnesota Med.*, 17: 68, 1934.
- ITZES, J. Meckel's diverticulum as a cause of partial occlusion of indirect hernia. *Orvosi hetil.*, 78: 714, 1934.
- KEELEY, JOHN L. Meckel's diverticulum in sac of ventral incisional hernia. *Wisconsin M. J.*, 36: 733, 1937.
- LAVATER, JOHANN CASPAR. Van der physiognomik. Leipzig, 1772.
- LITTRÉ, ALEXIS. Observation sur la nouvelle espèce de hernie. *Mém. Acad. roy. de sci.*, 1700: 300-310, 1719.
- MASON, GEORGE. Note on association of Meckel's diverticulum with hernia. *Newcastle M. J.*, 13: 73, 1933.
- MAY, J. MEYER. Meckel's diverticulum with peptic ulcer in strangulated inguinal hernial sac causing spontaneous fistulization and cicatrization. *Bull. Soc. med.-chir. de l'Indochine*, 13: 1102, 1935.
- MECKEL, JOHANN FRIEDRICH. Ueber die Divertikel am Darmkanal. *Arch. f. d. Physiol.*, 9: 421, 1809.
- Idem. *Handbuch d. path. Anat.*, 1: 579, 1812.
- Idem. Beitr. zur Entwicklungsgeschichte des Darmkanals. *Deutsche Arch. f. d. Physiol.*, 1: 293, 1815.
- MOSCHOWITZ, ALEXIS V. Hernia (in Alexander B. Johnson's Operative Therapeutics). Vol. iv, p. 129. New York, 1915. D. Appleton & Co.
- QUIRI, A. Meckel's diverticulum strangulated in crural hernia. *Arch. ital. di chir.*, 54: 16, 1938.
- RICHTER, AUGUST GOTTLIEB. Abhandlung von den Bruechen. Goettingen, 1777. J. C. Dietrich; idem, 1785.
- RIEKE, K. F. Ueber Darm-Anhangs-Brueche (Herniae Littricae). Berlin, 1841. A. Hirschwald.
- RINGO, R. E. and CHARLTON, M. R. Meckel's diverticulum and Littré's hernia. *Northwest Med.*, 39: 60, 1940.
- RODNER, E. R. Incarceration of Meckel's diverticulum in left inguinal hernia. *Kbirurgiya*, Nos. 2-3, 162, 1936.
- RUYSCH, FREDERIK. Observationum Anatomico-chirurgicarum. P. 23. Amstelodami, 1691. Henricum Vidua et T. Boom.
- Idem. Thesaurus Anatomicus. P. 63. Amstelodami, 1701.
- SINCLAIR, N. F. An unusual hernia. *Lancet*, 2: 762, 1922.
- STONE, HARVEY B. Hernia (in Dean Lewis' Practice of Surgery). Vol. vii, p. 13. Hagerstown, Md., 1929. W. F. Prior Co.
- WATSON, LEIGH F. Hernia. 2nd ed., pp. 331, 334, 509. St. Louis, 1938. C. V. Mosby Co.
- WEINSTEIN, BERNARD M. Strangulated Littré's femoral hernia with spontaneous fecal fistula. *Ann. Surg.*, 108: 1076, 1938.
- WILLIAMS, J. WHITRIDGE. Obstetrics. 2nd ed., P. 139. New York, 1909. D. Appleton & Co.

EXPLORATION OF THE COMMON BILE DUCT*

REVIEW OF 165 CASES

CAPTAIN DONALD H. HOOKER, M.C.

BALTIMORE, MARYLAND

THE following analysis of 165 cases in which the common bile duct was explored at operation was undertaken to add further statistical information and to clarify further this important problem. The average surgeon is prone to avoid opening the common bile duct because

tectomy has been performed on 2,117 patients. During this same period of time

TABLE I
YEAR

Year	Cases
1921-25.....	5
1926-30.....	30
1931-35.....	42
1936-40.....	88
Total.....	165

TABLE II
SEX

Sex	No. Patients
Male.....	51
Female.....	114
Total.....	165

TABLE III
AGE

Age (Decades)	No. Patients
0-9 years.....	0
10-19 ".....	1
20-29 ".....	6
30-39 ".....	27
40-49 ".....	49
50-59 ".....	45
60-69 ".....	34
70-79 ".....	3
Total.....	165

of additional dangers and technical difficulties that may be encountered. However, Lahey,¹ an advocate of common duct exploration, believes that in the hands of a competent surgeon who has had experience in biliary surgery, such a step does not entail any more danger to the patient.

At the Henry Ford Hospital over a period of the past twenty years cholecys-

TABLE IV
DURATION OF SYMPTOMS

Duration	Recent Attack	Earliest Symptoms
1 day to 1 week.....	56 patients	1 patient
1 week to 2 weeks.....	24 "	None
2 weeks to 3 weeks.....	6 "	"
3 weeks to 1 month.....	6 "	1 patient
1 month to 2 months.....	8 "	2 patients
2 months to 3 months....	2 "	5 "
3 " to 6 ".....	2 "	6 "
6 " to 1 year.....	1 patient	15 "
1 year to 2 years.....	1 "	12 "
2 years to 3 ".....	None	4 "
3 " to 6 ".....	1 patient	22 "
6 " to 12 ".....	None	17 "
12 " to 18 ".....	"	7 "
18 " plus.....	"	9 "
Unrecorded.....	58 patients	64 "
Total.....	165	165

TABLE V
NATURE OF SYMPTOMS

Location of Pain	With Nausea, Vomiting or Eructation	Without Nausea, Vomiting or Eructation
Right upper quadrant pain with radiation to back....	56 patients	11 patients
Epigastric pain.....	29 "	5 "
Right upper quadrant pain... Epigastric pain with radiation to back.....	27 "	4 "
Left upper quadrant pain...	18 "	1 patient
No abdominal pain (pruritus or chills or biliary fistula).	3 "	None
Unrecorded.....	10 "	1 patient
	None	

165 choledochotomies with exploration of the common bile duct were performed.

* From the Division of General Surgery, Henry Ford Hospital, Detroit.

Therefore, for approximately every thirteen cholecystectomies one choledochotomy was done.

Sex was found to be a significant factor because of the 165 cases in which the

TABLE VI
FREQUENCY OF ATTACKS

Frequency of Attacks	No. Patients
Many (above 8 attacks).....	85
Numerous (5-8 attacks).....	16
Few (0-4 attacks).....	51
Unrecorded.....	13
Total.....	165

TABLE VII
SEPTIC SYMPTOMS

Symptom	No. Patients
Chills and fever.....	64
Without chills and fever.....	101
Total.....	165

TABLE VIII
INCIDENCE OF CLINICAL JAUNDICE

Jaundice	No. Patients
With jaundice.....	122
Without jaundice.....	31
Unrecorded.....	12
Total.....	165

TABLE IX
PREVIOUS OPERATIONS ON THE BILIARY TRACT

Operation	No. Patients
Cholecystectomy.....	18
Cholecystostomy.....	6
Cholecystectomy	
Choledocotomy.....	4
Removal of stones from gallbladder.....	3
Cholecystectomy	
Drainage cystic duct.....	1
Cholecystgastrostomy.....	1
Total.....	33

common duct was explored, 114 or 69 per cent were females and fifty-one or 31 per cent were males. Other authors² have found this to be the case also.

Age appeared to play a rôle because over half of these patients were in the fifth and sixth decades; but the extremes were not free as the youngest patient was nineteen years old and the oldest seventy-three years.

Symptoms. Behrend³ states "the commonest symptoms of disease of the com-

mon bile duct are pain, nausea, vomiting and eructations of gas." Our findings (Table v) corroborate those of Behrend

TABLE X
ICTERIC INDEX

Readings	No. Patients
0-9.....	13
10-19.....	35
20-29.....	22
30-39.....	16
40-49.....	10
50-59.....	9
60-69.....	8
70-79.....	2
80-89.....	0
90-99.....	1
100-109.....	2
110-119.....	1
120-129.....	3
Unrecorded.....	43
Total.....	165

TABLE XI
BLEEDING AND CLOTTING TIME

Test	Bleeding	Clotting
Normal	(0-5 minutes) 34 patients	(0-5 minutes—capillary tube) (0-20 " —Howell) 28 patients
Prolonged.....	(5-10 minutes) 9 patients	(5-10 minutes—capillary tube) (20-40 " —Howell) 23 patients
Very prolonged	(10+ minutes) 1 patient	(10+ minutes—capillary tube) (40+ " —Howell) 3 patients
Unrecorded...	121 patients	111 patients

TABLE XII
VAN DEN BERGH REACTION

Reaction	No. Patients
Direct	
Prompt.....	39
Delayed.....	14
Negative.....	6
Unrecorded.....	106
Indirect	
Normal.....	9
1-2.....	7
2-3.....	6
3-4.....	7
4-5.....	7
5-6.....	6
6-7.....	1
7-8.....	15
Negative.....	1
Unrecorded.....	106
Total.....	165

since the great majority of our patients complained of a very definite pain always

located in the epigastrium usually on the right side and accompanied in most instances by nausea, vomiting or eructation. In a large number of cases onset of these

pruritus, or chills or a persistent biliary fistula.

Chills and fever suggest that an infection is present in the biliary tract. According

TABLE XIII
X-RAY EXAMINATION

X-ray Findings	No. Patients	Verified at Operation
Without stones.... Non-functioning	67	66 Most of these had stones but gallbladder appeared functionless
Gallbladder With stones.....	22	21 Stones may have been passed before gallbladder palpated
Normal gallbladder..	8	1

Flat Plate	No. Patients	Verified at Operation
Positive.....	2	2
Negative.....	16	3
(Cholangiogram) Pressure—extra biliary.....	1	1
Unrecorded.....	44	

TABLE XIV
BILIARY DRAINAGE TEST

Test	No. Patients	Verified at Operation
Normal.....	22	5
Stones.....	41	33
Infection.....	23	22
Biliary obstruction.....	6	6
Unrecorded.....		73

symptoms dated back two or three years. The most recent attack of pain and that which finally brought the patient into the hospital was usually of less than one week's duration. It is interesting that three of our patients suffered left upper quadrant abdominal pain and that ten of them had no pain whatever, their complaint being

TABLE XV
PRESENCE OF BILE IN URINE AND STOOL
Urine and Stool Bile

Reaction	No. Patients	
	Urine Bile	Stool Bile
Positive.....	89	71
Negative.....	47	33
Unrecorded.....	29	61
Total.....	165	165

TABLE XVI
WHITE BLOOD COUNT

WBC	No. Patients
0-5,000.....	5
5,001-10,000.....	81
10,001-15,000.....	45
15,001-20,000.....	14
20,001-25,000.....	2
25,001-30,000.....	3
30,001-35,000.....	1
Unrecorded.....	14
Total.....	165

TABLE XVII
PRE-OPERATIVE DIAGNOSIS

Pre-operative Diagnosis	No. Patients	Verified at Operation
Common duct obstruction		
Stone.....	73	57
Stricture or cancer		
Within duct.....	4	4
Pressure from outside (Ca of pancreas, glands).....	1	1
No Common Duct Obstruction		
Cirrhosis, hepatitis, cholangitis, carcinoma.....	4	4
Cystic duct stone.....	5	5
Cholecystitis, cholelithiasis....	77	43
Miscellaneous, persistent biliary fistula.....	1	1
Total.....	165	165

to Behrend,³ Symthe includes chills and fever in his summary of "clinical features

of stone in common bile duct" but remarks that "in Lahey's series, chills and fever were present in only 4.2 per cent of cases—a remarkably low figure which was attrib-

operations." Sixty-four cases in our series of 165 complained of chills and fever. *Laboratory Findings.* The icteric index was elevated in over half of the cases in this series and this might well be expected since

TABLE XVIII
LIVER FUNCTION

Liver Function	No. Patients
Good.....	12
Fair.....	12
Poor.....	11
Unclassified.....	14
Unrecorded.....	116
Total.....	165

TABLE XIX
TYPE OF RISK

Type Risk	No. Patients
Good.....	94
Fair.....	59
(Of the 59 patients in this group 20 had severe jaundice, 15 had cardio-vascular, 2 had bronehitis, 1 pulmonary t.b., 6 were afflicted with obesity, 5 with diabetes, 2 with poor livers, 1 with morphine addiction, 2 with epilepsy, 1 with rectal stricture, 1 with acute hepatitis, 2 with malnutrition and old age, 1 with acute pancreatitis.)	
Poor.....	4
(Of these 4 patients 3 had cardio-vascular, 1 had diabetes.)	
Unrecorded.....	8
Total.....	165

TABLE XX
OPERATORS

Operators	No. Operations
McClure.....	64
Fallis.....	30
Pratt.....	5
Harkins.....	1
Lam.....	8
Marshall.....	5
Altemeier.....	3
Davidson.....	3
Parr.....	3
Plain.....	2
Lambert.....	3
Noel.....	19
McGraw.....	5
Allen.....	11
Beaton.....	1
Robertson.....	1
Total.....	165

uted to the fact that a large proportion were operated upon early, and also to the practice of exploring the ducts in all biliary

TABLE XXI
CONDITION OF GALL BLADDER

Condition of Gallbladder	No. Patients
Chronic inflammation: stones.....	65
Chronic inflammation: no stones.....	60
Acute inflammation.....	9
Normal gallbladder.....	4
Gallbladder absent.....	22
Unrecorded.....	5
Total.....	165

TABLE XXII
PANCREAS

Pancreas	Chronic Process (No. Patients)	Acute Process (No. Patients)	Total
Thickened at head.....	8	0	8
Thickened throughout.....	36	4	40
Normal.....	48		48
Unrecorded.....	70		69
Total.....			165

TABLE XXIII
DILATATION OF COMMON DUCT

Common Duct	No. Patients
Not dilated.....	29
Moderately dilated.....	80
Very dilated.....	15
Unrecorded.....	41
Total.....	165

122 cases were clinically jaundiced. The icteric index (Table x) in the great majority of our cases remained below 50, but in three instances it was between 120 and 129 shortly before operation. The urine contained bile in well over half of the cases and the stool examinations were bile negative in approximately 1/5 of the total cases.

The white blood count was below 10,000 in eighty-eight cases (Table xvi) indicating that in these cases no acute inflammatory process was present. However, in fifty-nine cases the white blood count was between

10,000 and 20,000 and in six other cases above 20,000. This, correlated with the occurrence of fever and chills, suggests further that a rather large number of these patients had biliary tract infections.

TABLE XXIV
STONES IN COMMON DUCT

No Stones	No Patients
0	62
1	42
2	20
3	3
4	3
5	1
6++	19
Gravel	6
Unrecorded	9
Total	165

TABLE XXV
COMMON DUCT PROBED OR DILATED

Common Duct	No. Patients
Probed	88
Dilated	30
Not probed or dilated	20
Unrecorded	27
Total	165

TABLE XXVI
ADHESIONS

Adhesions	No Patients
Present	107
Absent	35
Unrecorded	23
Total	165

TABLE XXVII
CONDITION OF LIVER

Condition of Liver	No Patients
Scarred	30
Cirrhosis	21
Congested	15
Normal	32
Enlarged	16
Nodular	1
Small	1
Unrecorded	49
Total	165

Bleeding and clotting times were recorded on an insufficient number of patients from which to draw any satisfactory conclusions. Bleeding time was prolonged in ten of the forty-four and clotting time in twenty-six of the fifty-four cases re-

corded. This indicates that in at least a few cases blood coagulation was definitely prolonged.

Liver function tests were recorded on thirty-five cases in this series, twelve being classified as good function, twelve as fairly good function and eleven as markedly

TABLE XXVIII
DRAINAGE OF COMMON DUCT

Type of Drainage	No Patients
T tube	138
Catheter	17
No drainage closed	6
Unrecorded	4
Total	165

TABLE XXIX
NATURE OF OPERATION

Cholecystectomy	86	{ Duodenum opened into 3
Choledochostomy	patients	{ Stomach opened into 1
Cholecystectomy	41	
Choledochostomy	patients	
Appendectomy	19	
Choledochostomy	patients	
Miscellaneous		Patients
Cholecystectomy, choledochostomy, ap- pendectomy, repair of ventral hernia		3
Choledochostomy, appendectomy, repair of ventral hernia		1
Choledochotomy, release of adhesions		1
Cholecystectomy, choledochotomy		2
Choledochotomy, appendectomy		1
Choledochostomy, rectal dilatation		1
Cholecystectomy, choledochostomy, appen- dectomy, plication of sphincter		1
Choledochostomy, cholecystejunostomy, duodenum opened into		1
Choledochotomy, " "		1
Cholecystectomy, choledochotomy, trans- plantation of cystic duct into duodenum, duodenum opened		1
Choledochostomy, transplantation of com- mon duct into duodenum duodenum opened into		1
Cholelithotomy		1
Total		165

impaired function. Bromsulphthalein, oral and intravenous hippuric acid tests were employed in these cases.

Duodenal biliary drainage was employed in ninety-two patients and was found to be definitely helpful in arriving at a diagnosis. This was especially true when a positive report was obtained as seen in Table xiv. Our figures, however, do not

approach those reported by Backus⁴ who found that in a series of 148 proved cases biliary drainage was correct in 98 per cent of the cases.

It is exceedingly difficult to diagnose common duct pathology by routine x-ray examinations excluding of course the cholangiogram. An x-ray diagnosis of common

TABLE XXX
DRAINAGE

No. Drains	No Patients Having Cigarette Drains	No. Patients with G.B. Drains
1 drain	41	0
2 drains	38	3
3 drains	39	19
4 drains	3	3
5 drains	1	3
Gallbladder and cigarette drains		11 patients
No drains		1 patient
Unrecorded		6 patients
Total		165 patients

TABLE XXXI

TIME WHEN BILE CEASED TO FLOW

Post-operative Days	No. Patients
10-20 days	24
21-30 "	41
31-40 "	25
41-50 "	12
51-60 "	3
61-70 "	2
70 days plus	2
Unrecorded	56
Total	165

duct stone was made in only two instances in our series. The principal value of x-ray in the preoperative diagnosis proved to be in the determination of the condition of the gallbladder and the presence of calculi and in this series of the ninety-one x-ray diagnoses positive for biliary tract pathology eighty-nine were correct.

The value of the cholangiogram has been repeatedly emphasized by Best,⁵ Hunt and Hicken,⁶ Danzer,⁷ Saralegui⁸ and many others. The following two brief case reports taken from this series show how satisfactory such a simple procedure is in determining the patency of the common duct postoperatively.

CASE I. Case No. 283653. W. I., sixty-eight years of age, had many attacks of epigastric pain radiating to the back accompanied by nausea and vomiting. There was no jaundice. Lipiodol was injected into a T tube in the common duct one month after cholecystectomy and choledochostomy. X-ray revealed no obstruction in the common duct, so the T tube

TABLE XXXII
HEALING COMPLETE

Post-operative Days	No. Patients
10-20 days	5
21-30 "	16
31-40 "	38
41-50 "	26
51-60 "	18
61-70 "	4
70 days to 5 mos	5
Unrecorded	38
Dead	15
Total	165

TABLE XXXIII
RESULTS

Results	No. Patients
Well	120
Second biliary operation necessary	5
Ventral hernia	7
Recurrence biliary symptoms; spontaneous remission	10
Recurrence biliary symptoms without spontaneous remission	1
Died	22
Total	165

was removed and the subsequent clinical course verified the x-ray diagnosis.

CASE II. Case No. 300884. W. M., forty-eight years of age, suffered many attacks of epigastric pain accompanied by nausea and vomiting. There was a history of jaundice. One month after cholecystectomy and choledochostomy the clinical course of this patient suggested common duct obstruction. This was verified by cholangiogram. Then warm normal saline was irrigated back and forth through the T tube in the common duct and apparently the obstruction was relieved. Another cholangiogram was then taken and revealed no obstruction. This was verified by the clinical course.

Accuracy of Preoperative Diagnosis. In order to determine the accuracy of the preoperative diagnoses the operative find-

ings were investigated in each case. (Table xvii.) The greatest discrepancy occurred in those cases in which no common duct obstruction was suspected, for of these seventy-seven cases only forty-three proved to have no common duct obstruction.

Findings at Operation. The condition of the gallbladder was investigated as shown in Table xxi. It is not surprising

TABLE XXXIV
FOLLOW-UP

Time	No. Patients
1 day to 2 months	74
2 months to 4 months	29
4 " to 6 "	19
6 " to 1 year	10
1 year to 2 years.	12
2 " to 3 " .	5
3 " to 6 " .	8
6 " to 9 " .	6
9 " to 14 " .	2
	165

that in twenty-two cases the gallbladder had been removed because thirty-three patients had previously undergone operations on the biliary tract.

TABLE XXXV

OPERATIVE MORTALITY AND CAUSES OF DEATH
(Cases that did not leave hospital after operation)

Year	Causes of Death and No. Patients						
	Wound Hemorrhage	Cardiac Failure	Kidney Suppression (Uremia)	Banti's Disease Toxemia Poor Condition	Duodenal Fistula	Ruptured Aortic Aneurysm	Hepatic Insufficiency
1921-25	0	1	0	0	0	0	0
1926-30	1	0	1	1	1	0	0
1931-35	1	2	1	0	0	0	0
1936-40	2	2	0	0	0	1	1
Total	4	5	2	1	1	1	1

The pancreas was thickened and involved in a chronic process in forty-four cases and in an acute process in four cases. In only thirty-two cases could the liver be considered as grossly normal.

The condition of the common duct is summarized in Table xxiii. Slightly over

one-fifth of the cases showed no evidence of dilatation of the common duct. Adhesions were present in 107 cases.

Type of Operation Performed. Table xxix shows that in the majority of cases cholecystectomy was performed as well as a choledochostomy. In seven cases it was found necessary to open into the duodenum to determine the condition of the ampulla and common duct and in one case the stomach was opened. T tube drainage was used in 138 patients, a plain rubber catheter in seventeen, and in six, drainage of the common duct was not necessary. The duct was probed in 118 cases and the abdominal cavity was drained in all except one case.

Postoperative Course. In five of the cases the wound was completely healed in five days, but in half of the cases healing was not complete until forty days after operation. Bile ceased to flow from the wound in the majority of cases after the first month, but in several cases it persisted for over two months postoperatively.

Results. One hundred twenty patients were completely cured, five required another operation and twenty-two terminated in exitus. Table xxxiii summarizes the results.

The *follow-up* was extended to fourteen years in several instances but after two

months the number of patients seen again in the hospital sharply dropped off from seventy-four to twenty-nine and from then on the decrease was gradual.

TABLE XXXVI
POST-OPERATIVE DAY DEATH OCCURRED

P.O.D.	No. Patients
1-5 days	4
6-10 "	3
11-15 "	2
16-21 "	1
26-30 "	1
31-40 "	0
41-50 "	3
51-60 "	1
Total	15

TABLE XXXVII
ANNUAL AND TOTAL MORTALITY

Year	No. Patients	Per Cent (Annual Mortality)
1921-25	1	20
1926-30	4	13 3
1931-35	4	9 1
1936-40 ..	6	6 8
Total mortality 9%		

The causes of death are summarized in Table xxxv. Cardiac failure was the most frequent cause of exitus and wound hemorrhage occurred next in frequency. The deaths occurring from wound hemorrhage occurred before vitamin K was used in this hospital. Of the fifteen hospital deaths, nine of them occurred before the fifteenth postoperative day.

Annual and Total Mortality. Table xxxvii is of particular significance because it shows marked and progressive improvement in our mortality figures. The total mortality compares favorably with that of Frank Glenn² who reports a mortality of 12.5 per cent in 112 patients with non-malignant disease on whom the common duct was explored at operation. Thirty-eight per cent of the patients in our series were not considered good risk patients. This must have a direct bearing on our operative mortality.

CONCLUSIONS

One hundred sixty-five cases in which the common duct was explored at operation have been reviewed.

The hospital mortality has been reduced one-third of what it was twenty years ago; nevertheless exploration of the common duct still carries a higher mortality than simple cholecystectomy and should be resorted to only when there is a definite indication of common duct disorders.

REFERENCES

1. LAHEY, F. H. *Am. J. Surg.*, 40: 209, 1938; *New England J. Med.*, 213: 1275, 1935.
2. GLENN, F. *Ann. Surg.*, 112: 64, 1940.
3. BEHREND, MOSES M. *J. A. M. A.*, 116: 204, 1941.
4. BACKUS, H. L., SHAY, H. W. and PESSER, J. F. *J. A. M. A.*, 96: 311, 1931.
5. BEST, R. R. *Surg., Gynec. & Obst.*, 66: 1040, 1938.
6. HUNT, HICKEN and BEST, R. R. *J. Roentgenol.*, 38: 542, 1937.
7. DANZER, J. T. *Radiology*, 33: 508, 1939.
8. SARALEGUI, JOSE A. *Am. J. Roentgenol.*, 32: 167, 1934.
9. WALTERS, W. and SNELL, A. M. *Diseases of the Gallbladder and Bile Ducts*. Philadelphia, 1940. W. B. Saunders.



COMPLICATIONS OF THYROID SURGERY*

ANATOMY OF THE RECURRENT LARYNGEAL NERVE, MIDDLE THYROID VEIN AND INFERIOR THYROID ARTERY

CARL A. BACHHUBER, M.D.

Assistant Clinical Professor of Surgery, College of Medical Evangelists

LOS ANGELES, CALIFORNIA

THE most trying and serious complications resulting from thyroid surgery are mainly crisis, paralysis of the recurrent laryngeal nerves and hemorrhage. Since crisis is not directly due to the anatomical relationship of these structures, we are principally concerned with the anatomy as it regards the remaining two, namely, recurrent laryngeal nerve paralysis and hemorrhage.

The occurrence of unilateral injury of the recurrent laryngeal nerve may be distressing and at times alarming, but the symptoms resulting from bilateral injury assume serious proportions. Fortunately, however, the frequency of this complication is diminishing as the years pass and the percentage of injuries has been reduced from approximately 32 per cent in Bilothe's series as reported by Crotti¹ to a low series of 1½ per cent as reported by Lahey.² The frequency of occurrence of this accident depends to a certain extent upon how diligently one searches for the unilateral injury. There is no doubt that it occurs much more commonly than is reported in the literature.

Lahey² attributes his low incidence to the fact that he dissects out the nerve, deliberately exposing same, to avoid injury before resecting the gland. Prioleau,³ on the other hand, states, "It is an axiom in thyroid surgery that a recurrent laryngeal nerve seen is injured." Here we have diametrically opposed statements with the preponderance of evidence being against

the latter view, for the end result of any surgical procedure depends upon a good exposure and a thorough knowledge of the anatomy involved.

Many operators are under the impression that the most dangerous area for injury to the recurrent laryngeal nerve is the region of the inferior pole. This is quite erroneous for a review of the studies completed on the anatomical relationship of these structures finds the inferior pole in an area in which the recurrent laryngeal nerve would be least likely to be injured. From our studies it appears that the inferior thyroid veins can be ligated with safety at their point of exit from the gland.

Fowler and Hansen⁴ were greatly impressed by the fact that in the large majority of the cases the most intimate relation between the gland and the nerve was not at the lower pole as is generally assumed, but rather on the posterior lateral surface, at the junction of the middle and lower thirds of the organ, at or just above the point where the chief branches of the inferior thyroid artery enter the gland.

Rodgers⁵ states that the point of entrance of the recurrent laryngeal nerve corresponds to a point at or a little above the junction of the upper two-thirds with the lower one-third of the outer border of the lobe, but is on the posterior surface.

As a result of our studies based on one hundred dissections we most heartily concur with the above statements and are of the opinion that the point of entrance

* From the Surgical Service of the Los Angeles County Hospital and Department of Surgery, College of Medical Evangelists.

FIG. 1.

FIG. 2.



FIG. 3.

FIG. 4.

FIG. 1. Descending inferior thyroid artery. Recurrent laryngeal nerve split passing anterior to the inferior thyroid artery. Medium sized v. Middle thyroid branch of the inferior thyroid artery is as large as the continuation of the vessel.

FIG. 2. Descending inferior thyroid artery. Medium sized double v. Nerve posterior to vessels. Middle thyroid branch of inferior thyroid artery is about equal in size to the continuation of the vessel.

FIG. 3. Descending inferior thyroid artery. Medium sized v. Nerve passes through v. Middle thyroid branch of inferior thyroid artery is equal in size to the continuation of the vessel.

FIG. 4. Showing a large middle thyroid vein.

of the middle thyroid branch of the inferior thyroid artery and site of exit of the middle thyroid vein present one of the most constant glandular landmarks in thyroid surgery. It is with rare exception that these landmarks were not well defined, being located at the point of junction of the middle one-third of the gland with the lower one-third. The site of entrance of the middle thyroid branch of the inferior thyroid artery is at the posterior lateral surface and the point of exit for the middle thyroid vein is at approximately the same level but more anterior. It is at this level that the nerve approximates the gland, being in relationship with the posterior capsule.

Without exception the nerves passed posterior to the middle thyroid vein; and if the portion of the capsule which is to remain commences at this point, it is very unlikely that the nerve will be injured. However, the anatomy of the middle thyroid vein varies considerably not only in size but also in its termination. This variation will be discussed in another paragraph.

Too little stress is placed upon the thyroid branches of the inferior thyroid artery. Gray⁶ states that the inferior thyroid artery divides into two branches which supply the posterior inferior part of the gland and anastomose with the superior thyroid artery and the corresponding artery of the opposite side. Callander⁷ makes no particular mention of the terminal branches of the inferior thyroid artery, but an illustration beautifully depicts the inferior thyroid artery dividing into two main divisions before beginning its ramifications and divisions on the gland capsule. This branch which frequently was the principal vessel was absent but three times in the one hundred necks studied and often was considerably larger than the continuation of the inferior thyroid artery which enters the inferior pole of the lobe. This vessel which should definitely be called the middle thyroid branch or the middle thyroid artery enters the gland in relation to, or posterior to, the point of emergence of the

middle thyroid vein and can be considered as constant as the inferior thyroid artery itself.

Hertzler⁸ mentions the presence of a small artery in connection with the middle thyroid vein and also mentions the middle thyroid branch of the inferior thyroid artery which can be identified just lateral to the trachea and about one-half the distance between the two poles.

The inferior thyroid artery which it is presumed follows a transverse course from behind the carotid sheath, is a descending artery forming a loop; the superior or convex level frequently is on the same level as the point of entrance of the superior thyroid artery. This vessel with but few exceptions divides into two main branches forming the so-called v. This division may occur at any point after its emergence from behind the carotid sheath up to the capsule of the gland itself, the most usual point of this division being about 1 or 2 cm. from its point of entrance into the lobe.

The course of the recurrent laryngeal nerve in its relationship to this v has been frequently described. Nordland⁹ describes the following:

	Right Side	Left Side
Nerve anterior. . . .	15	11
Nerve posterior. . . .	8	11
Nerve through v. . . .	7	7
Inferior thyroid artery absent	1	2 Nerve branched around artery

Berlin's description of this relationship is as follows:

	Right	Percentage	Left	Percentage
Posterior to artery. . .	31	44	44	63
Anterior to artery. . .	28	40	17	24
Through v.	11	16	9	13

In our own dissections we have found the following:

	Right	Per-centage	Left	Per-centage
Posterior to artery .	33	33	55	55
Anterior to artery..	18	18	11	11
Through v.	48	48	33	33
Split around artery..	1	1	1	1

We are likewise of the opinion that the middle thyroid vein is frequently the source of troublesome bleeding and has been given insufficient attention. Gray⁶ states, "The middle thyroid vein collects the blood from the lower part of the lateral lobe of the thyroid gland and after being joined by some veins from the larynx and trachea terminates in the lower part of the internal jugular vein. Often in the place of the middle thyroid veins there are two veins the superior and inferior asscessory thyroid veins. These veins pass into the internal jugular."

In our dissections the frequent absence of the middle thyroid veins that joined the internal jugular was noticed. In a little less than 50 per cent of necks examined the middle thyroid vein would join the inferior or the superior thyroid plexus. Apparently, these are the veins alluded to by Gray⁶ under the name of asscessory thyroid veins.

The middle thyroid vein varies greatly in size, being from less than a mm. in diameter to a regular venous reservoir over 1 cm. in diameter. Many operators have the habit of freeing the gland from its bed by inserting the finger between the gland and its areolar coating and stripping the gland from its surrounding structures. This procedure must be very carefully carried out for one can readily see how easily it would be to overlook the middle thyroid vein, tearing same, with resulting troublesome hemorrhage. This accident is not liable to occur if the middle thyroid vein enters either the inferior or superior thyroid plexus of veins.

From the data here presented we are of the opinion that the most vulnerable area for injury to the recurrent laryngeal nerve and the most vulnerable site for hemorrhage is at the lateral posterior surface of the gland at the point of junction of the upper two-thirds with the lower one-third; for it is in this area that the middle thyroid artery enters the gland, the middle thyroid vein emerges from the gland, and the recurrent laryngeal nerve reaches the posterior surface of the gland, being in intimate relationship with the arterial vessels in this area.

One can readily see, how the presence of the recurrent laryngeal nerve anterior to the inferior thyroid artery and its middle thyroid branch in the presence of hemorrhage, would be quite likely to injury while attempting to control the bleeding; less likely to injury is the nerve when it passes through the v and least likely to injury if it is posterior to the arterial vessels.

CONCLUSIONS

1. The most vulnerable area of injury to the recurrent laryngeal nerve lies on the posterior lateral side of the gland at the point of junction of the middle one-third with its lower one-third.
2. The most probable source of hemorrhage is in this same area.
3. Attempt to control hemorrhage in this area is probably the cause of injury to the recurrent laryngeal nerve.
4. Thorough study of the anatomy in this area will tend to reduce the number of surgical complications and produce better end results, in that the surgeon will not remain too timid and remove sufficient portion of the gland to prevent a recurrence.

REFERENCES

1. CROTTI, ANDRE. Thyroid and Thymus. Philadelphia, 1918. Lea and Febiger.
2. LAHEY, FRANK H. and HOOVER, WALTER B. Injuries to the recurrent laryngeal nerves in thyroid operations. *Ann. Surg.*, 108: 545-562, 1938.

3. PRIOLEAU, W. H. Injury of laryngeal branches of vagus nerve in thyroid surgery. *South. Surg.*, 1: 287-292, 1933.
4. FOWLER, C. and HANSON, A. Surgical anatomy of thyroid gland with special reference to relations of recurrent and laryngeal nerve. *Surg., Gynec. & Obst.*, 49: 59-65, 1929.
5. ROGERS, LAMBERT. Thyroid arteries considered in relation to their surgical importance. *J. Anat.*, 64: 50-61, 1929.
6. Grays Anatomy. Philadelphia, 1913. Lee and Febiger.
7. CALLANDER. Surgical Anatomy. Philadelphia, 1939. W. B. Saunders Co.
8. HERTZLER, ARTHUR E. Technique of thyroideectomy. *Am. J. Surg.*, 62: 449-489, 1938.
9. NORDLAND, M. Larynx as related to surgery of thyroid based on anatomical study. *Surg., Gynec. & Obst.*, 51: 449-459, 1938.
10. BERLIN, D. D. Recurrent laryngeal nerves in total ablation of normal thyroid gland: anatomical and surgical study. *Surg., Gynec. & Obst.*, 60: 19-36, 1935.



THERE are two points of particular importance. First, where there is severe comminution, fragments of the patella must be removed and particular attention be paid to repair of the quadriceps tendon. Second, there must be careful plastic repair of the lateral ligaments not only from front to back but extending down on both sides of the knee from the point of the patellar fracture.

COMPLETE RECONSTRUCTION OF AURICLE

MORTON I. BERSON, M.D.

Director of Plastic and Reconstructive Surgery, The Downtown Hospital and Pan-American Clinic
NEW YORK, NEW YORK

DUE to the high percentage of war injuries which occur about the head, loss of the external ear has become a more frequent occurrence. Loss

brilliant green dye, a line is drawn circumscribing the margin of the model to delineate the location of the future auricle. An incision is made through the skin over



FIG. 1. Section of cartilage to be used as supporting framework of the auricle is removed from the seventh, eighth and ninth ribs.

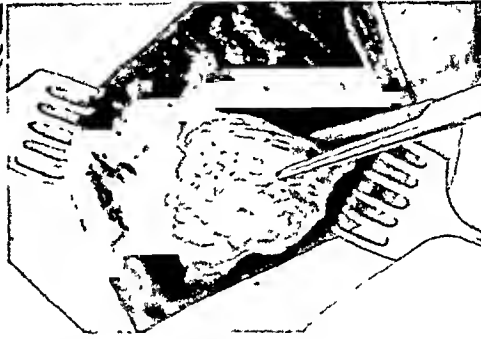


FIG. 2. Cartilage graft carved to mirror image of model of opposite ear.

of an auricle produces a psychic effect on the individual just as much as any other deformity and, therefore, should be accorded equal attention in reconstructive surgery. To avoid prolonged hospitalization and unnecessary loss of time, the author has modified the existing technics of reconstructing an auricle and reduced the operation to two stages.

OPERATION

Before the complete reconstruction is undertaken, the traumatic area must be free from any infection and completely healed. Also, if there are any remaining sections of cartilage or skin over the site of the auricle they should be removed and discarded.

First Stage. A preoperative model made of the patient's normal ear is reversed and placed along the temporomandibular region above and behind the external acoustic meatus, corresponding to the position of the auricle on the opposite side. With

the marking and a flap is lifted from the cranial periosteum up to the external auditory canal.

The necessary large section of cartilage for the supporting framework of the auricle is acquired as follows: The cartilage is exposed through a vertical incision 10 cm. long and 5 cm. from the midsternal line so that the middle of the incision is over the seventh costal cartilage. The incision is deepened to the rectus muscle which is separated in the direction of its fibers and the seventh, eighth and ninth costal cartilages are exposed at their sternal junction. The model ear is placed on the exposed cartilage and outlined with a knife on the perichondrium. By means of a raspator, the perichondrium is undermined around and under the surface of the ribs for the desired distance. The ends of the cartilage are cut through by cartilage shears and the section of cartilage is removed. (Fig. 1.) Severed vessels are clamped and ligated and towels are adjusted to the wound edges

by towel clips. The chest wound is closed in layers, a small rubber drain is inserted, dry gauze dressing applied and strips of adhesive firmly placed over the chest.



FIG. 3. The shaped rib cartilage graft is implanted in the prepared pocket between the scalp and temporo-mandibular fascia. This cartilage gives the structural support to the auricle.

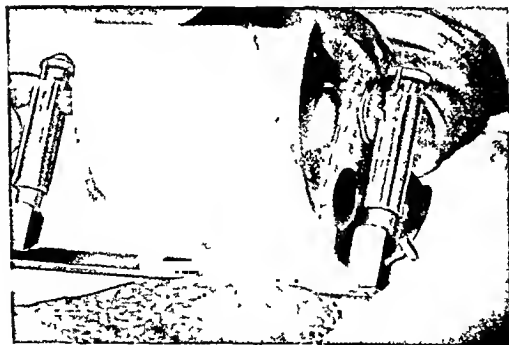


FIG. 4. A $\frac{3}{4}$ thickness skin graft is removed from the inner side of the thigh with the dermatome. The graft is 0.020 of an inch thick and 4 by 8 inches in size.

the temporomandibular fascia (Fig. 3) and the skin above it is sutured under tension by interrupted silk sutures. By means of a stent mold, the skin is pressed



FIG. 5. Skin graft for covering raw surfaces is wrapped over stent mold.

from without into the convolutions of the new auricular cartilage and a snug mastoid bandage applied for ten days.

Second Stage Four Weeks Later. A semi-lunar incision $1\frac{1}{2}$ cm. posterior to the proposed helix is carried through the temporomandibular fascia. The skin-cartilage flap is raised as far as the external acoustic meatus, care being taken not to cut into or expose the cartilage. The raised flap is now larger than the desired ear, due to the excess skin to be used for construction of the helix. The skin of the flap is undermined to a distance of 2 cm. from its external margin. This loose flap is curled and sutured on itself at the rim of the implanted cartilage to form the shape of the helix corresponding to that of the model ear. This produces a helix and lobule shaped according to the opposite ear. The amount of skin necessary to cover the surface area behind the new ear is marked on transparent lint. This pattern is placed over the thigh and a $\frac{3}{4}$ thickness skin graft, 0.020 of an inch in thickness, is obtained by the dermatome. (Fig. 4.) The skin, with the raw surface exposed, is wrapped over the stent mold modelled to fit the angle of protrusion of the normal ear, and held in place by sutures crossed above the stent mold at appropriate points. (Fig. 5.) The skin-cartilage flap with the helix completed looks exactly like the normal ear except for the lack of the posterior covering of the skin of the ear and the

The remaining perichondrium is completely stripped from the graft and the preoperative model made of the opposite ear is used as a guide in molding on the cartilage graft, the structural convolutions forming the helix, antihelix and concha. (Fig. 2.) The graft is then inserted into the prepared pocket between the scalp and



FIG. 6 Skin graft, wrapped in stent mold, is placed behind ear to cover defect area.

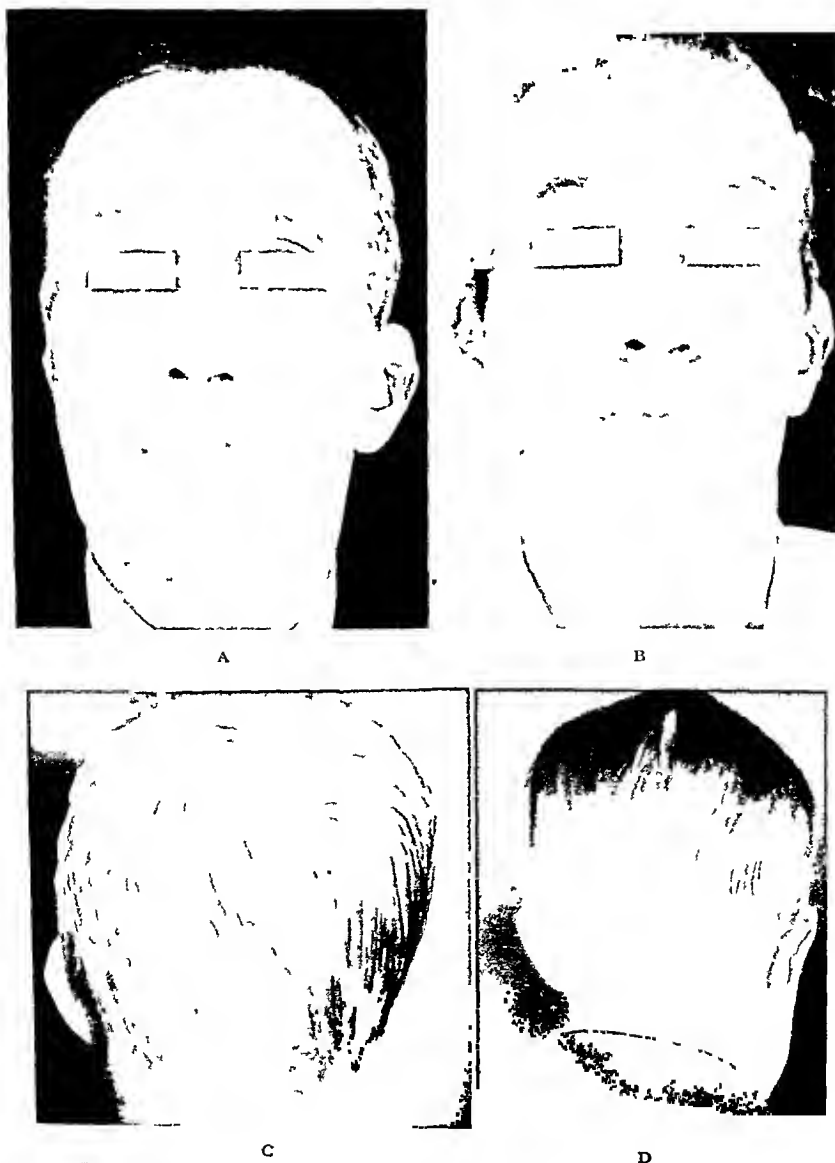


FIG. 7 Reconstruction of auricle following total loss due to trauma.

periosteal raw surface of the cranium. The stent mold, wrapped in the skin, is then placed under the prepared flap and pressed into the convolutions in order to favor the take. (Fig. 6.) The skin over the stent mold is approximated by means of interrupted silk sutures to the posterior margins of the newly formed helix and also to the skin borders along the neck. A firm mastoid dressing is applied over the ear for immobilization. After ten days, the exposed excess skin over the stent mold, which is now parchment-like, is trimmed and the stent mold is removed, thus leaving the back of the auricle and the neck lined with a $\frac{3}{4}$ thickness skin graft. The completed auricle now assumes its normal shape and position at the side of the head. (Fig. 7.)

SUMMARY

1. The operation is reduced to two stages.
2. Hospitalization has been reduced to a minimum of one week for the first stage and five days for the second stage with an interval of one month between the stages.
3. The use of the preoperative model and the stents aids in producing an auricle which is normal in size, the convolutions of helix, antihelix and concha corresponding to the opposite ear.
4. Inasmuch as the loss of an auricle is usually accompanied by other facial or body injuries, the reconstruction can be undertaken during the convalescent period and therefore does not incapacitate the individual for an additional length of time.



IN corrective operations for failure of union in fractures of the upper third of the humerus or femur, as in early fractures in these regions, special pains must be taken to immobilize the entire region of the shoulder and the hip. This is necessary both on account of the fracture itself and because of the danger of irritation, especially in the skin about the pin in the proximal fragment.

SULFATHIAZOLE ANURIA CURED BY DECAPSULATION OF THE KIDNEYS

CASE REPORT

M. L. WEINSTEIN, M.D.

AND

E. LAWRENCE ADAMS, M.D.

Member of Senior Surgical Staff, Chicago Memorial Hospital Associate Surgeon, Chicago Memorial Hospital
CHICAGO, ILLINOIS

THIS report is concerned with two aspects of sulfathiazole treatment; (1) a singular type of renal disorder caused by sulfathiazole, a sulfonamide which uncommonly produces anuria, and (2) the value of kidney decapsulation, a procedure the merit of which has been repeatedly questioned.

Since Antopol and Robinson,¹ Gross, Cooper, and Lewis,² and Toomey³ have reported their experimental work showing the renal pathological condition produced in certain animals given sulfapyridine, physicians have been more careful in the use of the drug. In their animal work, sulfapyridine concretions were found throughout the kidney tubules, pelves, and ureters producing a complete urinary obstruction. Southworth and Cooke's⁴ early publication of the symptom complex of hematuria, abdominal pain, and nitrogen retention associated with sulfapyridine ingestion made clinicians alert for clinical signs which might indicate that the use of sulfonamides should be discontinued. It is now known that any patient taking a sulfonamide should have frequent urine examinations as well as blood studies. On the appearance of a microscopic hematuria a careful vigilance must be kept; and should the hematuria become progressively worse and a macroscopic hematuria develop, the drug must be discontinued. There may be no hematuria but only an oliguria and later an anuria, making it quite important to watch the fluid intake and output.

This experimental work on sulfapyridine has been substantiated clinically in the writings of Carroll, Shea, and Pike,⁵ Plummer and McClellan,⁶ and Sadusk and

Waters.⁷ Winsor and Burch⁸ have pointed out the great importance of cystoscopy, ureteral catheterization, and irrigation of the kidney pelves with warm boric acid solution, saline, or distilled water.

Our purpose in presenting this material is to show (1) that acute sulfathiazole anuria may be due to a pathological reaction within the kidney parenchyma only; (2) that this anuria cannot be relieved by cystoscopy, ureteral catheterization and irrigation, and forcing intravenous fluids; (3) that kidney decapsulation may alleviate this condition; and (4) the renal disturbance in sulfathiazole anuria by a kidney biopsy, the first case reported to our knowledge.

CASE REPORT

Mr. H. P., a white, thirty-nine year old traffic manager, was admitted to the Chicago Memorial Hospital December 3, 1941. Discharged from hospital December 23, 1941. His chief complaints were vomiting, epigastric distress, subconjunctival hemorrhages and hiccoughs, all lasting four days.

The patient, a chronic alcoholic, consuming approximately a pint of liquor (whiskey) a day, felt "quite well" up to four to five weeks before hospitalization. After a debauch at that time, he developed a cold and cervical lymphadenopathy which were treated with sulfathiazole (9 Gm. in three days) and cough medicine. Apparently he recovered. Four days prior to entering the hospital, he awoke and could not stand even the odor of food. He began vomiting, at first mucus and later colorless, cloudy liquid which he was still vomiting when hospitalized. Each spell of vomiting was preceded and followed by a distressing attack of hiccoughs.

The patient had the feeling of a lump in his midepigastrium. His eyes were red in spots, and the "whites" of his eyes yellow. He ached all over.

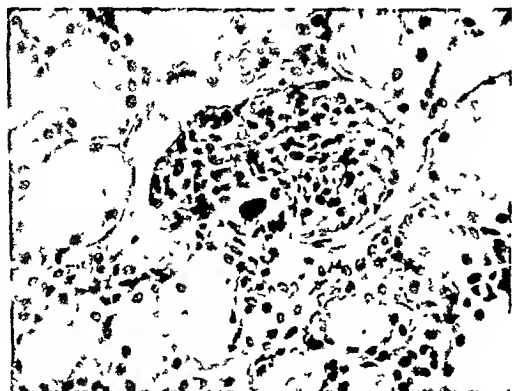


FIG. 1. Calcified calculus (sulfathiazole) at hilus of glomerular tuft (hematoxylin-eosin preparation).

The cardiorespiratory examination was negative. Gastrointestinal findings were vomiting and clay-colored stools. The urine was of a dark brown color preceding any previous recent medication (such as sulfathiazole); otherwise it was negative. Oliguria was present since onset of illness, i.e., four days before hospitalization. The neuromuscular examination was negative. He had had a gallbladder attack four years previous and whooping cough during childhood and tonsillectomy. Twelve years previous, he was in an accident in which head injury was sustained with a short period of unconsciousness.

Physical examination revealed the following: Pulse 72, temperature 97°F. respiration 18, weight 145 pounds. His skin and head (except eyes) were negative. His eyes revealed conjunctival hemorrhages; icteric sclerae. The thyroid and lymph-nodes did not enlarge to palpation. His chest was negative; blood pressure 115/70, rhythm regular, tones distant, no murmurs were heard. The lungs were clear and resonant. The abdomen was soft and round. Liver, kidneys, and spleen were not palpable. Rectal examination, bones, joints and extremities were all negative.

From December 3, the day of admission, to December 7, the patient received 1,000 cc. of 20 per cent glucose daily, intravenously, and took from 12 to 30 ounces of liquid by mouth. His urinary output was only $1\frac{1}{2}$ to $4\frac{1}{2}$ ounces per twenty-four hours and the blood non-

protein nitrogen was 115 mg. by December 6. On that day he was seen in consultation by Dr. Louis Leiter, who made a diagnosis of acute toxic hepatitis complicated, possibly, by

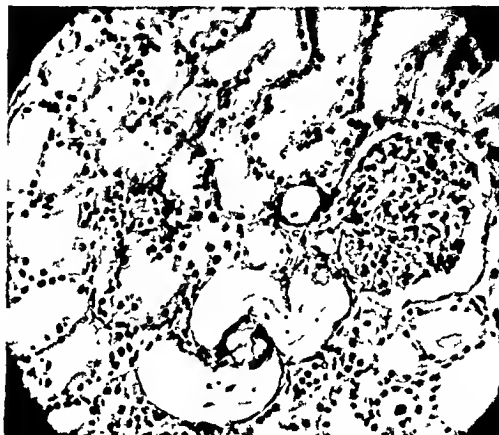


FIG. 2. Noncalcified calculus between dilated tubules (hematoxylin-eosin preparation).

an acute diffuse glomerulonephritis initiated by the upper respiratory infection of the previous month. Sulfathiazole was considered as a factor in the oliguria but was excluded on the basis of the time elapsed since its administration, the absence of pain along the urinary tract, and the absence of gross hematuria. The amount of parenteral fluids in the form of 5 or 10 per cent glucose and isotonic saline was increased. We decided to do cystoscopy and ureteral catheterization within twenty-four hours if the patient's urine volume did not increase promptly. On December 7, when cystoscopy revealed no obstruction below the kidneys and severe oliguria was persisting, Dr. Leiter was again consulted and a diagnosis of intrarenal edema or acute interstitial inflammation was made. We discussed the advisability of renal decapsulation in the event of continued failure of the patient to respond to diuretic measures. In the next forty-eight hours, the daily urine volume was $6\frac{1}{2}$ ounces and the specific gravity 1.008 to 1.011. The blood nonprotein nitrogen rose to 164 mg. and the creatinine to 21 mg. The patient was definitely getting worse, with periods of disorientation, oppression in the chest, some fluid in the abdomen, and a very tender liver. Decapsulation was decided upon after consultation with Dr. V. J. O'Connor, who stated that while there was little to expect from decapsulation, it was the only hope in sight. He recommended complete bilateral decapsulation under spinal

and gas-oxygen anesthesia, adequate drainage of the perirenal areas, and transfusion of plasma if serous drainage was profuse. The operation was carried out at 11 P.M. on December 9.

The anesthetic used was novocaine, 200 mg. in 3 cc. spinal fluid and ethylene. The following procedure was performed on each kidney: A Mayo incision (loin) was made through the skin, the fascia, the latissimus dorsi, and external and internal oblique muscles. The perirenal fat was incised and retracted and the kidney isolated. The capsule was smooth and glistening, and the kidney about 20 per cent enlarged. The capsule was incised on its convex curvature from pole to pole, and the kidney cortex was seen to "puff out" under the tight capsule. The capsule, which stripped easily, was stripped to either side and backward toward vessels. The kidney surface was greyish red with no petechiae. A hard round rubber tube was placed in the kidney bed and drain brought through one corner of incision and Penrose drain placed and brought out through the other. The entire abdominal incision was closed with interrupted silkworm sutures. Hemostasis was good. The pathological condition was severe congestion of kidneys. A biopsy was taken for microscopic study.

The microscopic study revealed the following: In a wedge-shaped section through the periphery of the kidney, the cortical tubuli were lined by swollen, frayed, and vacuolated cells. Within their lumina were desquamated epithelial cells, occasional red blood cells, basophilic and eosinophilic casts, and circumscribed, basophilic concretions. The glomeruli were occasionally hyalinized. At the hilus of some, concretions were noted. With the Von Kossa stain, these concretions were black (calcium).

The first few days were followed by a general improvement, as evidenced by the blood chemistry and blood pressure. There was a fair amount of drainage from the wounds, which subsided after the first five or six days. The temperature curve was never higher than 102°F. Otherwise, the course was uneventful and the patient was discharged recovered.

COMMENT

It is becoming more evident that the formation of urinary sulfonamide calculi has little to do with a lowered hydrogen

ion concentration of the urine; nor can this be prevented or corrected by alkalization.⁹ Forcing fluids to decrease the con-



FIG. 3. Note calcified calculus against wall of tubule, with desquamated epithelial cells and leukocytes within lumen. Smaller calculus in another tubule (hematoxylin-eosin preparation).

centration of the drug is important. Urinary concretions alone cannot be the reason that sulfonamide calculi form, for these occur in some patients who receive very small doses of the drug and who apparently are not dehydrated. On the other hand, patients may receive huge doses of the drug and no concretions form. It would seem more likely that some patients have a tendency to develop sulfonamide calculi just as some individuals acquire the ordinary urinary tract stones. The usual urinary calculi are formed over a long period of time, while sulfonamide calculi are formed rather suddenly. It would be interesting to check these patients for a history of previous stones and to follow them up to see whether other types of urinary stones are formed later. It is possible that some have what is analogous to a renal idiosyncrasy for the drug. This is suggested by the formation of calculi after small doses. This seems to be true for sulfapyridine, sulfathiazole, and sulfadiazine, which may produce sufficient renal damage to cause hematuria, oliguria, and/or anuria and death.⁹

The most interesting feature in this case report is that no concretions were formed in the kidney pelves, ureters, or urinary

bladder, but only within the kidney tubules. Utilizing the concept of Winton,¹⁰ the pathological physiology resulting from this renal damage perhaps was as follows: The concretions formed within the tubules produced a dilatation of the tubules, cloudy swelling of their lining cells, and some interstitial edema. This increased the intrarenal pressure and the latter along with the dilated tubules caused a partial venous obstruction, congestion of the kidneys, diminished blood flow and oliguria. Win-

ton¹¹ states that the increased intrarenal pressure associated with edema or engorgement may be an important factor in producing the oliguria which occurs in certain diseased conditions of the kidneys. Experimental work by Morison¹² shows that when there is a urinary obstruction producing hydronephrosis and damage to the tubules, the entire glomerular filtrate may be reabsorbed. The same principle could apply in intrarenal or intratubular obstruction. It is likely that the high in-

BLOOD

Date.....	12-3-1941	12-6-1941	12-8-1941	12-10-1941	12-11-1941	12-13-1941	12-15-1941
Red blood cells per c.mm.....	3,860,000	3,920,000	3,700,000	4,110,000	.....	4,030,000	4,030,000
Hemoglobin.....	78%	78%	74%	78%	.....	81%	76%
White blood cells per c.mm.....	11,100	12,200	11,800	15,000	.....	15,100	12,900
Neutrophils.....	92%	74%	74%	85%	.....	84%	80%
Eosinophiles.....	1%	1%					
Small and large lymphocytes.....	7%	18%	24%	12%	.....	14%	19%
Monocytes.....	.....	7%	2%	3%	.....	2%	1%
Coagulation time....	.....	.....	.....	.....	1 Minute		
Blood pressure.....	12-9-1941 140/70	12-10-1941 140/88	12-11-1941 140/72	12-12-1941 135/80	.....	12-15-1941 128/54	12-16-1941 120/58

BLOOD CHEMISTRY

Date.....	12-3-1941	12-6-1941	12-9-1941	12-11-1941	12-13-1941	12-19-1941
Icterus index.....	16 units					
Nonprotein nitrogen.....	115 mg. per 100 cc.	164 mg. per 100 cc.	142 mg. per 100 cc.	103 mg. per 100 cc.	37 mg. per 100 cc.
Creatinine.....	21.4 mg. per 100 cc.	.....	.....	1.9 mg. per 100 cc.
Chlorides as NaCl.....	Serum chloride 550 mg. per 100 cc.			
Plasma cholesterol.....	Total cholesterol, 100 mg. per 100 cc. serum. % Esters, 58		

12-11-1941
12-12-1941

Patient's prothrombin time, 20.5 seconds; control, 18 seconds.
Patient's prothrombin time, 19 seconds; control 17 seconds.

Wassermann and Kahn—Negative.

Date (1941)	Fluid Intake, 24-hour Amount, (Cc.)	Urine										
		24-hr. Amt., (Cc.)	Color	Re- ac- tion	Sp. Gr.	Albu- min, (Mg.)	Microscopic					
							Casts	Blood Cells	Pus Cells	Crys- tals	Ep. Cells	Bact.
12-4	1360	135	Dark, turbid	Acid	Q.N.S.	100	Occ. granular	10-12	10-15	Urates	Mod.	
12-5	2000	45	" "	Acid	Q.N.S.	100	Occ. granular	10-20	Occ.			
12-6	3000	75	" "	Acid	Q.N.S.							
12-7	2200	150	Yellow, cloudy	Acid	1 011	Loaded	Coarse granu- lar, loaded					
12-8	2800	120	Bloody	Alk.	1 012				Many			
12-9	2100	0	Bloody (Operation, 11 P.M.)	Alk.	1 008		Large granular					Bact.
12-10	2750	870	Yellow, clear	Alk.	1 010	100	Few granular	75-100	10-20			
12-11	2100	800	Yellow, sl. turb.	Acid	1 013	75	Occ. granular	75-100	4-6			Bact.
12-12	2440	2880	Yellow, clear	Alk.	1 010	30	Few granular	25-50				
12-13	3600	3870	Straw, clear	Acid	1 010	10	Occ. granular	10-15	3-5			
12-14	3420	3300	Straw, clear	Acid	1 010	15	Occ. granular	10-15				
12-15	3200	2580	Yellow, clear	Acid	1 012	10	Occ. granular	6-8	10-15			
12-16	2760	2160	" "	Alk.	1 010	20		3-5	5-10			
12-17	3420	1800	" "	Acid	1 013	20	Mod. granular	10-20	25-50			
12-18	3030	1650	" "	Alk.	1 010	0	Many granular	5-10	10-20			
12-19	2580	1530	" "	Acid	1 014	10	Mod. granular	3-4	10-15			
12-20	2640	1500	Amber, clear	Alk.	1 012	20	Few granular	Occ.	10-15			
12-21	3060	1380	Amber, clear	Acid	1 018	10	Many hyaline granular and cellular, bile- stained	0	10 Occ. clumps			
12-22	3060	930	Yellow, clear	Alk.	1 012	0		0	5-10			
12-23	3000	1620	" "	Alk.	1 012	0	Mod. granular	Rare	10-12			
		12-4 to 12-23, incl: Sugar and/or Ace- tone: 0										

CYSTOSCOPIC

Date	Bladder	Urine	Ureteral Orifices	Function
12-7-1941	Normal	Straw-colored	Both normal	Poor. Few drops urine.
12-7-1941	Indigocarmine test: No dye in 20 minutes.			

trarenal pressure present in this case, as evidenced by the marked bulging of the kidneys after decapsulation, is the explanation for the cause of the anuria. After the kidney damage has reached a certain point and the intrarenal pressure has been elevated, the process may become irreversible and no amount of parenteral fluids will rectify the condition.

Antopol and Robinson¹ offer experimental data on animals suggesting that the obstructing crystalline mass can be dissolved or washed out. They suggest also the possibility that a certain amount of kidney damage precedes the formation of concretions within the kidneys. The microscopic study of the cortical biopsy in our patient substantiates the latter possibility, for there was a distinct disproportion between the small number of concretions present and the complete anuria which resulted. It may be that many of the larger collecting tubules within the pyramids were obstructed but were not seen in this biopsy of the cortex. Since the tissue was stained with hematoxylin and eosin, it is also likely that many of the concretions and casts were washed out of the section.

It is conceivable that severe oliguria may occur as a result of tubular degeneration caused by the sulfonamide drug with little or no associated calculous formation.¹³ This condition would be analogous to findings in cases of post-transfusion anuria, in which the tubules do not contain obstructing casts.¹⁴

Decapsulation of the kidneys was first performed by Reginald Harrison¹⁵ in 1878 for acute nephritis following scarlet fever. This surgical procedure has been shown to be of considerable value¹⁵ in certain acute kidney diseases which do not respond to medical treatment and are complicated by hematuria, oliguria, and anuria with a mounting nitrogen retention and impending death. The use of decapsulation for all forms of Bright's disease by Harrison, Edebohls, and Ronsing¹⁵ gave such inconclusive results that the procedure was nearly abandoned. But it should be borne

in mind that some acute kidney diseases such as acute nephritis following scarlet fever, acute suppurative nephritis, and mercurial nephrosis associated with oliguria and/or anuria and uremia may be cured by decapsulation of the kidneys.

A number of theories has been advanced for the beneficial effect of the operation in these cases. This report lends credence to the theory of Harrison¹⁵ that the decapsulation simply released the great intrarenal pressure which, on the basis of the above physiological concept,¹¹ would be most responsible for the anuria.

In the case reported, there seems little doubt that the raised intrarenal pressure was relieved by decapsulation, for the kidneys bulged a great deal when they were decapsulated. The patient was almost completely anuretic for three days, getting progressively worse, and developing severe uremia before decapsulation was performed. He urinated shortly after the operation and began to improve, leaving little doubt that the operation was directly responsible for saving his life.

SUMMARY AND CONCLUSIONS

1. A case of anuria caused by sulfathiazole therapy is presented.
2. Anuria was due to concretions within the kidney tubules, which most likely caused a rise in intrarenal pressure and cessation of the flow of urine. Damage of tubular epithelium probably was a contributing factor.
3. Treatment by cystoscopy and ureteral catheterization is useless in this type of case, although it must be performed to exclude calculi in the pelves and ureters.
4. Bilateral kidney decapsulation is indicated in persistent sulfathiazole anuria when medical treatment fails.
5. The amount of renal damage seems less than that caused by sulfapyridine.
6. Microscopic hematuria and oliguria may be the only ominous signs in an impending sulfathiazole anuria.
7. Harrison's theory that the success of kidney decapsulation is based on the re-

lease of an increased intrarenal pressure receives further substantiation.

8. The pathological reaction of the kidney cortex produced by sulfathiazole is presented.

REFERENCES

1. ANTROPOL, W. and ROBINSON, H. Pathologic and histologic changes following oral administration of sulfapyridine, with a short note on sulfapyridine. *Arch. Path.*, 29: 67, 1940.
2. GROSS, P., COOPER, F. B. and LEWIS, M. Urinary concretions caused by sulfapyridine. *Proc. Soc. Exper. Biol. & Med.*, 41: 448, 1939; Urinary calculi caused by sulfapyridine. *Urol. & Cutan. Rev.*, 43: 299, 1939; The fate of urinary calculi caused by the administration of sulfapyridine. *Ibid.*, 43: 439, 1939.
3. TOOMEY, J. A. Urinary concretions and sulfapyridine. *J. A. M. A.*, 113: 250, 1939.
4. SOUTHWORTH, H. and COOKE, C. Hematuria, abdominal pain and nitrogen retention associated with sulfapyridine. *J. A. M. A.*, 112: 1820, 1939.
5. CARROLL, G., SHEA, J. and PIKE, G. Complete anuria due to crystalline concretions following the use of sulfapyridine in pneumonia. *J. A. M. A.*, 114: 411, 1940.
6. PLUMMER, N. and McCLELLAN, F. The production of sulfapyridine renal calculi in man following administration of sulfapyridine. *J. A. M. A.*, 114: 943, 1940.
7. SADUSK, J. F. and WATERS, L. L. Treatment of anuria due to sulfapyridine calculi. *J. A. M. A.*, 115: 1968, 1940.
8. WINSOR, T. and BURCH, G. E. Renal complications following sulfathiazole therapy. *J. A. M. A.*, 118: 1346, 1942.
9. DETWEILER, H. K. and MACKAY, A. Sulfathiazole anuria with recovery. *Canad. M. A. J.*, 45: 242, 1941.
10. WINTON, F. R. *J. Physiol.*, 72: 153, 1931.
11. WINTON, F. R. *J. Physiol.*, vol. 77, 1933.
12. MORISON, D. *Proc. Roy. Soc. Med.*, 22: 219, 1928.
13. HELLWIG, C. A. and REED, H. L. Fatal anuria following sulfadiazine therapy. *J. A. M. A.*, 119: 561, 1942.
14. DE GOWIN, E. L., WARNER, E. D. and RANDALL, W. L. Renal insufficiency from blood transfusion etc. *Arch. Int. Med.*, 61: 609-630, 1938.
15. NICHOL, L. F. *Canad. M. A. J.*, 43: 577, 1940.



TREATMENT OF SHOCK AND FRESH WOUNDS*

HENRY H. RITTER, M.D.

Professor of Clinical Surgery, New York Post Graduate Hospital and Medical School, Columbia University
NEW YORK, NEW YORK

NEVER was the need for a sound knowledge of the cardinal principles of the surgery of wound treatment greater than it is today. With practically the entire world at war and with a great burden resting upon our nation, it is necessary that we keep our soldiers at the front fit for fighting and our peoples in industry fit for production, especially since it is estimated that twenty persons in industry are required to care properly for the needs of one of our soldiers at the front.

It is, therefore, timely for us to discuss the treatment of wounds and of shock following trauma. Wounds comprise the greatest number of all accidents. An accident is something that nobody is ever prepared for; there is no prodromal period and, as a rule, it is associated with shock to a greater or lesser degree. The very young and the very old are easily shocked.

SHOCK

Shock is associated with circulatory breakdown. The circulation is dependent upon (1) peripheral-vascular resistance, (2) blood volume, and (3) action and force of the heart beat.

In shock, the peripheral resistance is lowered because of dilatation of the capillaries and, as a result of the stasis that follows, there is an exudation of plasma into the soft tissues. This loss of fluids diminishes the blood volume and the force of the venous return flow to the heart is greatly lessened, and so the force and action of the heart beat is greatly disturbed. With the plasma loss is associated a loss of proteins and a relative increase in the cellular content of the blood. Because of the sluggish circulation, there

follows faulty oxygenation of the blood. With the protein loss, there is a change in the albumin-globulin ratio, because of the more rapid loss of albumin from the blood stream. An increase in the hematocrit reading is always seen with a loss of plasma. The viscosity of the blood is increased. Of course, when shock is due to hemorrhage, there is no change in the hematocrit reading and no change in the albumin-globulin ratio. Probably, the simplest way to differentiate between shock due to hemorrhage and that due to loss of plasma is by a simple blood count. In hemorrhage, the red blood cells and hemoglobin rapidly go down; while in shock due to loss of plasma, the red count and hemoglobin are increased. A fall in blood pressure follows shock, but it does not initiate shock.

The causes of shock are pain, cold hemorrhage, toxemia, cerebrospinal damage, and injuries. The signs of shock are restlessness, pallor, thirst, rapid pulse, cold clammy skin, vertigo, superficial rapid respirations and air hunger, and vary depending upon the causative factor.

Primary shock occurs immediately following an injury. It may be a temporary circulatory disturbance of vasomotor origin. Secondary shock comes on some time after injury and may be the result of faulty treatment or infection.

TREATMENT OF SHOCK

The most important treatment is prevention. Control of bleeding must have priority over all else. An injured person should be relieved of pain and anxiety by proper sedation. He should be kept warm by the use of blankets, hot water bottles, heat lamps, etc. If there is bleeding, it

* Read before the Lehigh Valley Medical Society, Allentown, Pennsylvania, the American-Hungarian Medical Association, New York City, and the Rockaway Medical Society, Lawrence, Long Island.

should be immediately controlled. The foot of the bed should be elevated.

If there is a wound, it should be properly protected and fractures should be splinted.

When shock occurs, fluids must be given by every avenue; namely, via the veins, skin, rectum and mouth. Glucose, 5 per cent in normal saline, is probably the easiest to obtain and is readily given by vein.

If the shock is due to hemorrhage, a transfusion of whole blood is indicated. If it is due to loss of plasma, then an infusion of plasma should be given, 250 cc., 500 cc. or 1000 cc., depending upon the loss. Oxygen by the Boothby mask is of great value.

FRESH WOUNDS

In the treatment of fresh wounds, first control excessive bleeding; if possible, by clamping the blood vessels and tying. Mass ligation is frowned upon. Temporary moderate bleeding may help to flush foreign bodies from the wound.

Wounds are classified as, incised, punctured, lacerated, contused and abraded. The incised bleed most freely. The incised and abraded do not require débridement; the contused and lacerated do and the punctured may.

By fresh wound, we mean the wound seen within eight hours after the accident ("The Golden Period"). All wounds not made with surgical intent should be considered contaminated. We have, as yet, no antiseptic that will destroy all organisms without destroying living tissues. The sulfonamides are bacteria-static to a very great extent, but not absolute bactericides. Their use is urged; their great value has been proved.

A prophylactic injection of 1,500 units of tetanus antitoxin should be given immediately and carefully. Make sure that the patient is not sensitive to the antitoxin. Of course, when the wound has occurred in a bath tub or in a tile bath room or when it is the result of a clean instrument, such an injection may not be necessary. A

second injection of 1,500 cc. of tetanus antitoxin should be given after one week and with the same care.

All wounds should be properly cleansed. If there is grease or grime about the wound, it should be temporarily packed with sterile gauze or closed with clips and the surrounding skin cleansed with a solvent, such as gasoline, benzine or kerosene and washed with plenty of warm water and soap and dried. The wound should then be opened, irrigated with copious quantities of warm normal saline, allowed to bleed gently and dried. Devitalized tissue will soon be evident by its lack of color, lack of bleeding and loss of elasticity. All devitalized tissue should then be excised and only normal tissue should be seen. All foreign material should be removed from the wound if readily reached. Following débridement, the wound is again irrigated with large quantities of saline. The wound is carefully inspected; any severed tendons and nerves are found and immediately repaired with silk sutures. From 5 to 15 Gm. of sulfanilamide powder is then sprinkled into the wound so that no great amount of the powder is in any one area. The wound is loosely closed in anatomic layers; its edges gently approximated and with no tension. Every wound should be drained with rubber bands or rubber tissue for from twenty-four to forty-eight hours. Sulfonamides have been used. As a matter of fact, wounds may be allowed to remain open for twenty-four to forty-eight hours and, if no infection occurs, sutured. Primary union will follow.

There is much agitation against drainage, but I have seen no bad results therefrom, and union does occur by first intention. It is better than suturing immediately and having to remove sutures because of infection.

All wounds should be immobilized in the optimum position and the part elevated. Rest promotes healing and prevents re-infection. Infrequent dressings are urged.

Wounds of the pleura and of the peritoneum should be closed at once. The

tissues should be treated as described and the sulfonamides dusted into the pleura or peritoneum.

Punctured wounds with large underlying hematomas or associated with large subcutaneous damage should be enlarged, the bleeding stopped, the hematomas evacuated, and the wound packed with sulfanilamide and treated as described above.

CONCLUSIONS

1. There are two outstanding advances in the treatment of shock and wounds: (1) The use of blood plasma, which is now readily obtainable and requires no typing; (2) the use of the sulfonamides.
2. Control of hemorrhage takes priority over all other local treatments.
3. The treatment of primary shock and prevention of secondary shock are necessary before wound treatment.

4. Intravenous plasma infusion is the most important single item in the treatment of shock. The prompt, adequate and, if necessary, repeated infusion of plasma will restore the circulating blood volume, increase the venous pressure, increase the cardiac output, relieve capillary stasis and tissue anoxia and restore proteins.

5. Infection in fresh traumatic wounds is most effectively prevented by copious irrigation with warm normal saline solution followed by débridement and implantation of sulfanilamide or sulfathiazole powder.

6. The question of closure with or without drainage is dependent upon the length of exposure, the thoroughness of the débridement, and the experience of the surgeon. Delayed closure of all wounds, except of the pleura or peritoneum, is suggested.



Case Reports

SACROCOCCYGEAL CHORDOMA*

REPORT OF A CASE

LOUIS OLSMAN, M.D. AND MAURICE LEV, M.D.†

CHICAGO, ILLINOIS

CHORDOMA was first reported by Müller¹ in 1858, and extensively studied anatomically, histologically, and experimentally by Ribbert² in 1894. Alezais and Peyron,³ in 1914, demonstrated the histogenesis and evolution of the tumor. Since then comprehensive reviews of reported cases and further studies have been made by Stewart,⁴ in 1922, Eckel and Jacobs,⁵ in 1925, Coenen,⁶ in 1925, Stewart and Morin,⁷ in 1926, Capell,⁸ in 1928, Grinda,⁹ Machulko-Horbartzewitch and Rochlin,¹⁰ Fletcher,¹¹ and Babrey,¹² in 1935. The latter found 150 cases of chordoma in the literature, distributed as follows: cranial, forty-nine; vertebral, fourteen; and sacrococcygeal, eighty-seven. Since then about thirty further cases of sacrococcygeal chordoma have been reported.

We present here a case of sacrococcygeal chordoma with the unusual complication of perforation into the peritoneal cavity.

CASE REPORT

The patient, a seventy-three-year old Italian male, was admitted to the Chicago State Hospital on May 5, 1938, as a case of psychosis with cerebral arteriosclerosis. For several years prior to admission the patient had episodes of depression, delusions of persecution, and violently jealous delusions concerning his wife. After an attack on her in which she sustained a skull fracture, the patient was committed to an institution.

Medical history obtained from the patient's

relatives revealed that eleven years prior to his admission the patient had sustained an injury to the base of his spine. The region became very painful and an operation was performed in 1927, the nature of which is unknown. The pain recurred with increasingly severity and in 1934 the patient was again operated upon. A cystic tumor of the sacrum was evacuated and partially resected. Microscopically, the tumor was diagnosed a chordoma. The wound healed well and the patient remained fairly comfortable. In July, 1938, while a patient in the Chicago State Hospital, he was referred to the hospital ward because of persistent constipation. Proctoscopy, performed by Dr. Louis Block, revealed a posterior rectal mass, hard, and partially obliterating the lumen. X-ray (Fig. 1) revealed cystic degeneration of the sacrum with irregular areas of calcification. Because of the patient's advanced age and poor physical condition it was believed best to leave the tumor alone. The patient was examined at periodic intervals and the tumor appeared to be stationary.

On August 26, 1940, the patient was admitted to the hospital ward with abdominal cramps, mild distention, and a rectal temperature of 101°F. Physical examination revealed abdominal spasm, generalized tenderness to moderate palpation, and rebound tenderness. On the following day the patient became more distended, began vomiting, and Levine suction, intravenous fluids and sedation were instituted. Laparotomy was advised and performed by Dr. A. V. Partipilo, under ethylene-ether anesthesia. As the peritoneum was opened, a large amount of thick fecal-smelling fluid gushed forth. Because of the patient's poor physical

* From the Departments of Surgery and Pathology, Chicago State Hospital. † Since the submission of this article, both authors have joined the armed forces.

condition, three Penrose drains were inserted and the abdomen closed. The patient's course continued downhill and he expired on the day following surgery.



FIG. 1. X-ray of the sacrum, showing a cystic and moth-eaten appearance.

Postmortem examination revealed the body to be that of an emaciated white male about seventy years of age. Over the sacral region a moderately firm mass about 8 cm. in greatest diameter could be felt in the subcutaneous tissue. On section this mass was found to be continuous with tumor tissue which had replaced most of the sacrum (Fig. 2), pushed the rectum forward and enveloped it, as well as extended upward behind the sacrum. The peritoneum in this region was necrotic. The tumor tissue was in parts friable and in parts semifirm. The cut surface presented a mosaic of red and yellowish grey, glossy-looking areas. The tumor had perforated into the rectum in several regions so that a fistulous tract was formed between the rectum and the peritoneal cavity. The lining of the peritoneal cavity was dull and granular throughout. The loops of small intestine were mutually adherent although the loops separated with ease. Between these loops there were pockets of purulent material. The sigmoid colon, as it slipped down behind the urinary bladder produced a pocket of thick pus. The retroperitoneal tissue of the left gutter was dull greenish gray and purulent.

The heart presented an old infarct in the anterosuperior wall of the left ventricle with a corresponding mural thrombus and old pericarditis. The coronary arteries were markedly sclerotic with narrowing of the lumen of the ramus anterior descendens and the left circum-

flex branch. The lungs were the seat of edema. The liver and spleen were grossly not remarkable. The urinary tract showed an obstruction of the bladder neck, left hydroureter, acute

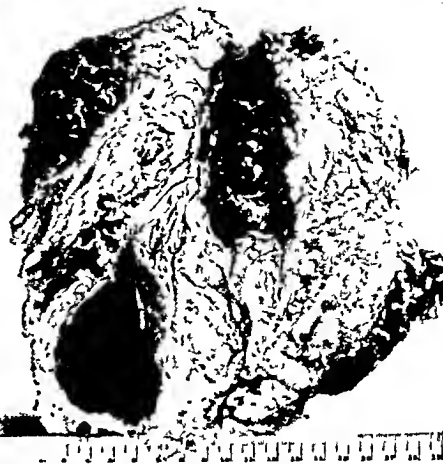


FIG. 2. Dorsal view of sacrum and subcutaneous connective tissue. The sacrum is almost completely replaced by tumor which also invades the subcutaneous tissue.

ureteritis and pyelitis. There was a recent infarct in the right kidney.

Histologic examination of the tumor (Figs. 3 and 4) showed the following: hematoxylin and eosin, and van Gieson revealed irregular pockets of tumor tissue separated by trabecules of varying thickness. The tumor tissue varied in appearance as follows: (a) Some pockets consisted of well demarcated large cells which differed markedly in size and shape. The nuclei were irregular, some small, some large, with dense nuclear membranes and scant chromatin material. The arrangement of chromatin was such as to present a honeycombed or vacuolated appearance. No mitotic figures were noted. The cytoplasm was slightly basophilic, markedly vacuolated and varied in abundance, being in some cases moderate in amount, and in others very abundant. (b) Some pockets consisted of a sea of slightly basophilic staining homogeneous material in which were scattered poorly demarcated large cells. (c) Some pockets showed a periphery of relatively small and moderately sized cells. Internal to these were cells with more abundant vacuolated cytoplasm. The center of the pocket consisted of a pale blue staining material with scattered nuclei.

The nature of the trabeculas likewise varied. Very little collagen was found in some trabeculas with scattered connective tissue nuclei.

findings of destruction of the sacrum, and (4) constipation.

The history of injury in this patient is of



FIG. 3. A typical section of the tumor (hematoxylin and eosin preparation) $\times 64$.

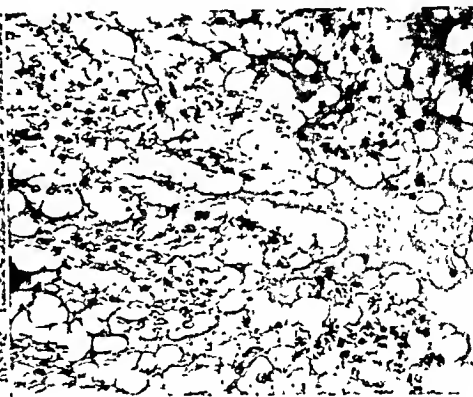


FIG. 4. Higher power of same section (hematoxylin and eosin preparation) $\times 240$.

These trabeculas consisted mostly of eosinophilic amorphous material which stained yellow with van Gieson's; other trabeculas consisted of collagenous connective tissue. Some trabeculas consisted of extravasated blood cells. In many cases the trabeculas were not sharply demarcated from the tumor tissue and seemed to be part and modification of the latter. Many widely dilated, thin-walled vascular channels were present in the trabeculas and within the tumor tissue proper.

The pathologic diagnosis was: (1) Chordoma of the sacrococcygeal region with invasion of the sacrum, the subcutaneous tissues over the sacrum, and the retroperitoneal tissue about the rectum and sigmoid; (2) acute and chronic inflammation of the retroperitoneal tissue; (3) perforation of the rectum; (4) acute suppurative peritonitis; (5) obstruction of the urinary bladder, left hydronephrosis, acute ureteritis, and pyelitis. There were incidental pathological conditions in many other organs.

COMMENT

From the clinical standpoint this case presented the unusual complication of involvement of the peritoneum with the production of acute peritonitis. Otherwise the usual symptoms and signs of a slow-growing sacrococcygeal chordoma with anterior and posterior extension were present: (1) severe pain in the sacral region, (2) palpation of a mass through the posterior wall of the rectum, (3) x-ray

interest. Babrey¹² found a history of trauma in 26 per cent of all sacrococcygeal cases, and Fletcher, Woltman, and Adson¹³ found it in two of their ten cases. Trauma may thus be a factor in the production of chordoma in this region.

From the pathological standpoint, the tumor here presented is a relatively benign type of chordoma. There is a great deal of mucinous material, many physaliphorous cells, with a few compact small epithelioid-like cells. No mitotic figures are present. These characteristics speak for relative benignity. The general histologic features of chordoma are (1) formation of intracellular and extracellular mucinous material and the presence of physaliphorous or highly vacuolated cells containing mucinous material, (2) the lobular or pocket arrangement of tumor cells, (3) vacuolization of the nuclei, and (4) the close resemblance to the various stages of development of notochordal tissue.

From the standpoint of histogenesis chordomas are considered to be derived from either (a) persistence of notochordal tissue in an abnormal situation, or (b) traumatic release of notochordal tissue from a region where it is normally found.¹⁴ Thus chordomas may be found in the region of the clivus, occipital bone, hypophyseal region, nasopharyngeal region,

alveolar region, cervical, thoracic, or lumbar vertebral column, and in the sacrococcygeal region, where they are most numerous.

REFERENCES

1. MÜLLER, H. Ueber des Verkommen von Resten der Chorda dorsalis bei Menschen nach der Geburt und über ihr Verhältniss zu den Gallertgeschwülsten am Clivus. *Ztschr. f. Nationelle Med.*, 2: 202, 1858.
2. RIBBERT, H. (a) Ueber die Eechondrosis physalifora spheno-occipitalis. *Centralbl. f. allg. Path.*, 5: 457, 1894. (b) Ueber die experimentelle Erzeugung einer Eechondrosis physalifora. *Verb. d. Congresses f. inn. Med., Wiesbaden*, 13: 455, 1895.
3. ALEZAIS and PEYRON. Sur l'histogencse et l'origine des chordomes. *Compt. rend. Acad. des sc.*, 174: 419, 1922.
4. STEWART, M. J. Malignant sacrococcygeal chordoma. *J. Path. & Bact.*, 25: 40, 1922.
5. ECKEL, J. L. and JACOBS, W. F. Malignant spheno-occipital chordoma. *J. Nerv. & Ment. Dis.*, 61: 471, 1925.
6. COENEN, H. Das Chordom. *Brun's Beitr. z. klin. Chir.*, 133: 1, 1925.
7. STEWART, M. J. and MORIN, J. E. Chordoma: a review with a report of a new sacrococcygeal case. *J. Path. & Bact.*, 29: 41, 1926.
8. CAPELL, D. F. Chordoma of the vertebral column with three new cases. *J. Path. & Bact.*, 31: 797, 1928.
9. GRINDA, J. P. Les chordomes sacrococcygiens. Paris, 1930. Masson et Cie.
10. MACIULKO-HORBARTZEWITSCH, G. S. and ROCHLIN, L. L. Klinik Pathomorphologie und Histogenese der Chordomc. *Arch. f. Psychiat.*, 89: 222, 1930.
11. FLETCHER, E. M. Thesis, University of Minnesota, December, 1933.
12. BABREY, R. E. Chordoma. A study of 150 cases. *Am. J. Cancer*, 25: 501, 1935.
13. FLETCHER, E. M., WOLTMAN, H. W. and ADSON, A. W. Sacrococcygeal chordomas, a clinical and pathological study. *Arch. Neurol. & Psychiat.*, 33: 283, 1935.
14. BRUCE, J. and MEKIE, E. Chordoma. *Surg., Gynec. & Obst.*, 65: 40, 1937.



A MUSCULOSPIRAL paralysis complicating a fracture of the humerus can sometimes be left to recover with operation, provided the fracture is properly reduced and relief to the nerve is afforded in the treatment.

ACUTE PERFORATION OF A DIVERTICULUM OF THE SIGMOID

TREATMENT BY OPERATION AND SULFANILAMIDE

CHARLES HAINES, M.D.

NEW ROCHELLE, NEW YORK

SUDDEN perforation of an acutely inflamed diverticulum of the sigmoid is an unusual accident. Still more unusual is recovery from such an accident. Isolated reports of sudden perforation of an acutely inflamed diverticulum of the sigmoid usually followed by general peritonitis and death within a few hours, whether or not the patient is operated upon, have been reported in the literature. Rankin and Brown say: "Acute perforation of a mobile segment of a colon is unusual. We have seen it in an occasional case in the Clinic (Mayo) . . . our experience is small in this type of case and the mortality rate is high."

The sudden emptying of feces from the sigmoid into the clean peritoneal cavity, which immediately causes a violent peritonitis, has been in most cases too great a shock for the patient to withstand and death has been the outcome.

The following report of a case of sudden perforation of an acutely inflamed diverticulum followed by complete recovery emphasizes a few salient points worthy of consideration:

CASE REPORT

I first saw Mr. R. G. (Case No. 99325) at the New Rochelle Hospital in consultation with Dr. William Le Furgy on the evening of February 5, 1941. Dr. Le Furgy had sent him to the hospital about a week previously because he was having a severe attack of grippe.

During this week in the hospital the patient had had a low grade fever and an increased pulse rate. There had been a cough and some discomfort in the chest. However, toward the end of the week the patient's condition im-

proved and convalescence seemed to be comparatively satisfactory.

Mr. R. G. had never had any complaints referable to the abdomen. On the morning of February 5th, the day I first saw him, he was feeling comparatively well but, his bowels not having moved for two days, he had been given a soap-suds enema at 1:00 P.M. The nozzle of the enema tube was said by the nurse to have been inserted just within the anal sphincter and the enema bag held about three feet above the level of the anus. A few minutes after the enema had been started the patient complained of sudden and severe pain in the lower part of the abdomen. This pain was severe enough so that he cried out. The enema was stopped at once; the bowels did not move. The patient immediately became nauseated and vomited several times. He did not go into shock. During the next seven hours there were severe abdominal pain, nausea and vomiting. The abdomen, which had been only moderately distended, became markedly distended. The patient probably did not pass any gas by rectum during the afternoon. When I saw the patient at 8 P.M. the temperature, which had been normal on the preceding day, was 102.8°F. by rectum and the pulse 120 per minute.

Examination, seven hours after the enema, showed an elderly white man in bed complaining of nausea and of severe pain in the lower part of the abdomen. He was acutely ill. He gave the impression of being at least five years older than his stated age of sixty-six years.

He was conscious but not entirely rational. The skin was soft, smooth and dry. The tongue was dry and markedly coated. The heart action was rapid. The abdomen was markedly distended. There was moderate tenderness in the left lower quadrant of the abdomen with marked tenderness and marked rigidity in the right lower quadrant. There was also some tenderness in the right upper

quadrant of the abdomen. Percussion of the right chest anteriorly showed a sharp change from the normal pulmonary note to a tympanic note over the liver. No dullness over the liver could be made out. Rectal examination showed no mass and no tenderness.

The white blood count which had been normal a few days previously was now 23,000 with 93.5 per cent polymorphonuclear cells and 36 per cent young forms.

Sagittal x-ray films were taken with the patient lying on the left side. They showed a definite collection of air between the liver and the lateral abdominal wall.

I made a clinical diagnosis of rupture of the large intestine, exact site not determined. I advised immediate operation in spite of the fact that the patient's general condition was so bad that I considered it practically desperate.

One thousand cc. of 5 per cent glucose in normal saline solution were given by vein. The patient was taken to the operating room about 11:00 P.M., ten hours after the enema. A spinal anesthetic of pantocaine 15 mg. was given. During the operation an additional 1,000 cc. of 5 per cent glucose in normal saline were given by vein.

For the reason that the maximum tenderness was in the right lower quadrant of the abdomen I made the incision through the right rectus muscle below the level of the umbilicus. On opening the peritoneum a large quantity of fluid containing small pieces of fecal matter floated into the wound. The peritoneal cavity was seen to be distended by this fecal matter from the lower large intestine. All of the peritoneum which I saw was markedly inflamed.

I sucked out about 1,000 cc. of colon bacillus—smelling fluid from the peritoneal cavity. Gentle examination of the large intestine showed an indurated segment of the sigmoid just to the left of the midline. This indurated segment of the sigmoid was brought into the wound. A perforation about 1.0 cm. in diameter was found on the antimesenteric border through what was apparently a diverticulum. Surrounding the perforation there was an area of induration about 5.0 cm. in diameter. It being impossible to close the perforation because of the induration of the intestinal wall, I exteriorized it.

I put two handfuls of sulfanilamide powder into the peritoneal cavity and into the sub-

cutaneous wound. I then closed the wound around the sigmoidostomy and made no attempt to drain the peritoneal cavity.

A Levin tube was inserted immediately after operation and the stomach was drained intermittently for six days. Thereafter the tube was discontinued.

The spinal anesthetic had been entirely satisfactory. The patient was returned to bed in poor condition; so poor that the family were told the outlook for his recovery could not be optimistic. It hardly seemed possible that a man of his age and general physical condition could withstand so overwhelming an infection. However, during the first twenty-four hours after operation his general condition improved markedly. He became rational. He was interested in his surroundings. On the day following operation the temperature reached a maximum of 100.8°F. by rectum and the pulse a maximum of 105 per minute. The rectal temperature reached normal on the fourth day after operation and remained normal throughout the remainder of his stay in the hospital except for three days when it went as high as 102°F. During these three days examination showed a few râles at the base of the lungs which may account for the rise of temperature.

For the first week after operation the patient was given daily from 2,000 to 4,000 cc. of 5 per cent glucose in normal saline or in distilled water. In this way the quantity of urine secreted was kept between 1,000 and 1,900 cc. a day. The patient was also given 5 cc. of neoprontosil intramuscularly every four hours for four days after operation.

The concentration of sulfanilamide in the blood stream during this time was found to be between 6.5 mg. and 7.5 mg. per 100 cc. of blood. A culture of the fluid removed from the abdomen showed colon bacilli.

The improvement in the general condition of the patient was surprisingly satisfactory. Locally the wound healed kindly. There was at no time distention, rigidity or great tenderness of the abdomen. The patient passed gas by rectum a few days after operation. On the day following operation he took fluids by mouth. A week after operation he was having a soft diet without untoward results. Twelve days after operation he was allowed to sit in a chair. Two weeks after operation he was given a transfusion of 475 cc. of citrated blood because of a

mild anemia. At this time he was having a liberal diet.

He was kept in the hospital for six weeks after operation. At the time of discharge from the hospital the abdominal wound was well healed around the sigmoidostomy. The opening into the intestine was only 1.0 cm. in diameter; there was almost no discharge from it, and the patient was having normal bowel movements. He was walking about in his room and was enjoying comparatively good health.

Since his discharge from the hospital the patient has steadily improved in health. He was able to return to his work as a guard in a bank about three months after operation. Now, fifteen months after operation, he feels strong and well. The opening into the intestine, however, is still present and shows little indication of healing. There is a hernia of moderate size around the abdominal scar.

Except for the fact that the patient is obliged to wear a pad over the sigmoidostomy he has no complaints referable to the accident or to the operation.

CONCLUSIONS

This case illustrates a few points which are important: (1) Even an acute perforation of the sigmoid in an elderly patient does not necessarily mean death. (2) The value of the x-ray in showing gas between the liver and the lateral abdominal wall when films are taken with the patient lying on the left side. (3) The value of a spinal anesthetic in the management of generalized peritonitis. (4) The great value of sulfanilamide placed within the peritoneal cavity in the presence of a general soiling with sigmoid fecal material. (5) The excellent result which was obtained in this case without drainage; drainage would undoubtedly have been a liability rather than an asset. (6) The value of exteriorizing the sigmoid at the site of rupture rather than attempting to close the perforation. (7) The smooth postoperative course which this patient has enjoyed.



SURGICAL TREATMENT OF MEDICAL JAUNDICE

CASE REPORT

DEAN MACDONALD, M.D.

On Staff of St. Catharines General Hospital

ST. CATHARINES, CANADA

AND

H. RAYMOND DRYSDALE, M.D.

Instructor in Medicine, University of Rochester School
of Medicine and Dentistry

ROCHESTER, NEW YORK

IN a previous communication¹ one of us described a method of, and the early results of, postoperative perfusion of the biliary ductal system (intra- and extrahepatic) using fluids heated by thermostatic control. The follow-up of this work has produced many interesting findings, one of which is this: The volume of bile flowing from a T-tube may be increased as much as five times, following intrahepatic lavage with heated fluids, 125 to 140°F., as registered by a thermometer at the T-tube entrance. (Fig. 2.) The clinical significance of this finding lies in the fact that the application of controlled heat, *to the individual liver cells*, may greatly increase the efficiency of the liver as a working unit. This fact has a wider clinical application in that, if this hypothesis is proved correct, the present therapy of some forms of liver disease, particularly the cases of so-called medical jaundice, may become radically changed. This paper concerns the report of a case which indicates that this hypothesis has much foundation in fact. The case history will follow a brief resume of the original paper which is given so that the reader may better understand the case presentation and discussion.

Résumé. Rearrangement of biliary anatomy does not, and cannot, remove *all* the pathological condition, either causative or resultant, of biliary tract disease, even though the symptoms may be completely relieved. Something other than cholecystectomy must, therefore, be necessary. This "something else" is often the presence of a normal ductal system, *both in and out of the liver*. One of the principles of biliary

surgery should be the production of such a normal system in as far as this is possible; that is, to promote normal physiological functions throughout the biliary system, which extends *from the smallest bile radical to the duodenal mucosa*. The successful accomplishment of this will prevent, in a maximum degree, the occurrence of further symptoms. On this premise it was thought (1) that the more thorough cleansing of the ductal system which would result from perfusion, and (2) the application of heat to the interior of, and to the actual disorder in the biliary system would improve the overall end results of surgical treatment. This thought was also based on the recognized fact that the present methods of treatment (T-tube or catheter drain) do not always produce normal conditions in the ducts. That the present methods of operative and postoperative treatment in general are not always successful is evidenced by the work of many and is a fact recognized by all. Among the partially or wholly correctable causes of postoperative symptoms are calculi remaining in the ducts, pancreatitis, cholangitis, hepatitis, and a nervous imbalance of the choledochoduodenal apparatus. It was suggested that the incidence of these conditions might be lowered following controlled perfusion and internal lavage with heated fluids, and that the end results would, therefore, be improved.

The theoretical and practical value of this procedure was discussed under the following headings: (1) *Uphill versus downhill drainage* i.e., T-tube drainage versus perfusion. The quantity of drainage bile was found to be larger and drainage was

better along the normal natural anatomical downhill passage (common duct) than it was through a τ tube which drains uphill, and only then when the intraductal pres-

disease. It was argued that the use of heat by this method theoretically improves the blood and lymph circulation of the biliary system, including the pancreas, and that

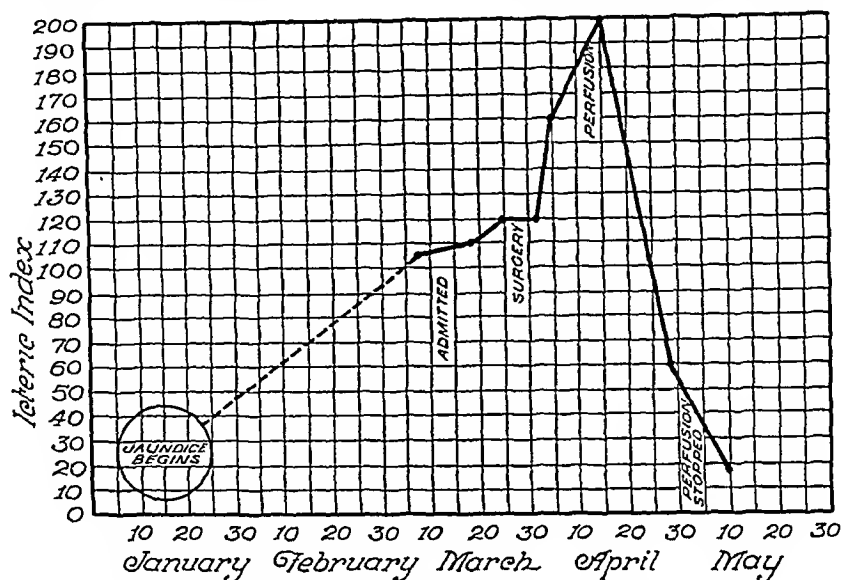


FIG. 1. Shows graphically the gradually increasing icteric index and the rate at which it receded following treatment by perfusion.

sure is greater than the perpendicular height of the tube. Also in uphill drainage only the lighter material floats to the top; the heavy debris stays at the bottom in the duct. (2) *Small duct involvement* (intrahepatic): When the resistance of the sphincter of Oddi was increased by morphine, and the patient placed in the Trendelenburg position, slow perfusion allowed the fluid to penetrate into the small intrahepatic radicals. It is too seldom appreciated that these smaller but important branches of the larger biliary tree are often involved in biliary disease, particularly in obstructive cases (repeated jaundice), and that on many occasions an insufficient effort is made to correct this condition. Heat and intrahepatic cleansing fluids (lavage) were shown to be an improvement. (3) It was found that the common duct was more thoroughly cleansed by perfusion under controlled pressure than by a τ tube or catheter drain which is, in reality, only an overflow. (4) *Pancreatitis*: The importance of long and continued drainage of the common duct is a recognized method of treating pancreatitis associated with biliary

it might improve the treatment of residual pancreatic pathological states. (5) *Dilation of the sphincter*: It was suggested that slow, continuous and controlled dilation of the sphincter should have many advantages over acute surgical dilatation. It produces less trauma and is theoretically more permanent. That the sphincter can be dilated was shown by the fact that, after three months perfusion, the perfusion time was greatly reduced even though larger amounts of fluid were used at a much lower pressure. (6) *Postoperative colic*: The incidence of such colic was shown to be theoretically greatly lessened. (7) *Ductal washings*: That cleansing is much more thorough by perfusion than by the τ tube overflow was seen when the perfusion fluid was collected through a duodenal tube and compared to τ tube drainage.

Conclusions. It was proved that the ductal system could be cleansed by perfusion more thoroughly than by τ tube drainage; that small stones might be washed or "flushed" out of the common duct; that controlled heat could be applied

simply and easily for prolonged periods to the interior of both the intra- and extrahepatic biliary system and that the end results of surgical treatment should

extrahepatic obstructive disease, probably carcinoma of the head of the pancreas, was made. Surgery was performed by Dr. Houck on March 27. Thorough exploration revealed

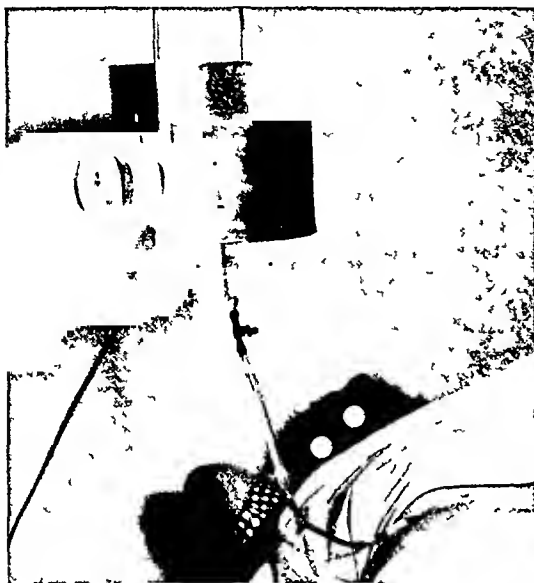


FIG. 2. The apparatus as shown is attached to a T tube. An intravenous thermometer records the temperature of the fluid at the point of abdominal entrance. The recording end is placed at the T tube entrance so that the heat loss between the mercury bulb and the point of distribution is minimum. The Baxter intravenous jar is encased in a water chamber which is heated by the thermostatic control on the outside, and the vacuum drip emerges through an opening at the bottom.



FIG. 3. The insulated cover has been removed and the apparatus turned on the side to show the interior. The intravenous jar fits snugly into the central hollow which is surrounded by water. It is arranged in this way so that the jar may be removed and replaced with ease. Stop-screws control the rate of flow. An opening, which is on the far side and cannot be seen, allows the fluid level to be viewed at all times.

thereby be improved in a certain number of cases, particularly those complicated by inflammatory and/or obstructive lesions as small calculi, pancreatitis, sphincter imbalance, cholangitis and choledochitis.

CASE HISTORY

The following case is reported briefly as an example of the possible clinical application of biliary perfusion in the treatment of intrahepatic (medical) jaundice:

Mrs. L., age seventy-four, entered the hospital in Rochester, New York, March 14, 1941. Her only complaint was "jaundice" which had been present and progressive for approximately seven weeks. She first consulted a physician on March 3, eleven days before admission. Her icteric index at that time was 105. Four days after admission (March 18) the index was 110. A provisional diagnosis of

no obstructive lesion and a section of the liver was removed for biopsy. A T tube was placed in the common duct. The pathological report of the liver section revealed a thickened capsule; numbers of small bile ducts were isolated from liver tissue; in the portal areas masses of infiltrating round cells were seen, giving the appearance of lymph follicles. There was no evidence of malignancy. The pathological diagnosis was "chronic hepatitis."

Eight days after operation the icteric index had risen to 160; twelve days after operation it had reached 200. (Fig. 1.) Shortly after this the patient began to show early signs of advancing cholemia; the temperature became unsteady and the pulse lost quality; lethargy increased; mental instability appeared, and the bile drainage from the T tube was "thinner than water," very small in amount and showed practically no color. A bad prognosis was given by both the medical and surgical consultants.

On April 16, twenty days after operation, perfusion was started. (Fig. 2.) During this twenty day postoperative period the icteric index had risen from 120 to 200. There was no extrahepatic obstruction as determined by cholangiographic study and a postoperative diagnosis of intrahepatic jaundice had been made. Five hundred cc. of 5 per cent glucose in normal saline was given once a day. The temperature of the perfusing fluid varied between 115 to 130°F. On April 29, (thirteen days after starting perfusion) the icteric index had dropped to 60. Ascites, probably due to the excessive administration of sodium chloride, developed on May 1. On May 3, seventeen days after the start of perfusion, it was discontinued. The T tube was removed on May 5. On May 10, her icteric index was 18. (Fig. 1.) On May 1, 1942, she had had no recurrence of the jaundice and was enjoying apparent perfect health.

DISCUSSION

A case of proved intrahepatic (medical) jaundice which had been gradually increasing in severity for eleven weeks began to subside immediately following the institution of biliary perfusion and it soon disappeared. (Fig. 1.) The logical question is: Was this prompt remission of the jaundice a coincidence or was it the result of perfusion? The writers believe that it was not a coincidence and that the result here reported was the direct consequence of a definite treatment. The condition of the patient had been growing steadily worse over a period of eleven weeks before perfusion was started. It is most unlikely that spontaneous improvement should have begun at this moment when all other methods of therapy had previously failed. Marked clinical improvement was clearly seen in thirteen days. (Icteric index fell from 200 to 60, from April 16 to April 29.) If this improvement was not the result of perfusion, what other factors could be involved? It is clear that the circumstantial evidence is overwhelmingly in favor of perfusion.

This report must not pass as just another "interesting case." It opens a field of therapy that is far reaching in its possibilities. For example, what might it not do for

the other forms of liver disease such as multiple abscesses, postoperative hepatic insufficiency, suppurative cholangitis or other cases of intrahepatic jaundice.

The chief argument against the use of perfusion is that it is a surgical procedure which must be used on a sick patient. We now "watchfully wait" beside the patient with medical jaundice (and other intrahepatic conditions) because there is nothing else to do. The treatment is many times only supportive, which in itself is supported by hope and prayer. Neither of these measures attack the etiology. Perfusion of the intrahepatic ductal system does.

From a clinical standpoint, in the very few cases studied, it seems that the application of controlled heat (120 to 140°F.) to the liver cell and to the actual seat of the disorder, by means of ductal perfusion, does relatively and absolutely increase the efficiency of the liver as a working unit, as determined by the greatly increased flow of bile.

Because it is uncommon to have a T tube in the common duct of a patient with medical jaundice, and because biliary perfusion suggests a new and hopeful approach to a large field, and because the war prevents planned experimental work being carried out, a single case history is considered worthy of presentation. This report is made with the hope that it will stimulate a thorough discussion and investigation of the subject.

CONCLUSION

Because one case is insufficient evidence on which to base any conclusion, and because much experimental and clinical work remains to be done, it is suggested, rather than concluded, that this method of treatment opens up a new and beneficial field in the therapy of liver disease. This is sufficient justification for the present presentation.

REFERENCE

1. MACDONALD, DEAN. Post-operative perfusion of the biliary ductal system. *Canad. M. A. J.*, 43: 411-418, 1940.

MULTIPLE PRIMARY NEOPLASM OF THE COLON*

JOHN HERRLIN, JR., M.D.

Associate Professor of Surgery and Attending
Surgeon, New York Medical College,
Flower and Fifth Avenue Hospital

AND

WALTER L. MERSHEIMER, M.D.†

Assistant to the Director of Surgery, New York
Medical College, Flower and Fifth Avenue
Hospital

NEW YORK, NEW YORK

IT is well known that carcinoma of the colon (with the rectum) accounts for over one-tenth of all deaths due to malignant disease.¹ Operability of neoplasms of the colon is estimated to be from 38 to 81 per cent and the mortality for radical operation averages about 20 per cent.² The incidence of multiple primary malignancy is variously estimated between 0.6 and 4.3 per cent.³ Therefore, although it may no longer be a rarity, the successful radical removal of multiple primary carcinoma of the colon seems worthy of consideration and is the subject of the present report.

Salient facts are worthy of repetition. It is said that Cserny, in 1880, was the first surgeon successfully to resect multiple carcinomas of the colon.⁴ In 1918, Major, in an exhaustive review of the literature, recorded 628 examples in which multiple primary malignant lesions were found.⁵ Multiple neoplasms were reviewed by Warren and Gates in 1932 and they collected more than 1,200 cases of multiple primary malignancies. There were fifty-five cases of multiple carcinoma of the colon. Bacon, in 1939, collected and reviewed 155 cases of multiple primary malignant lesions involving the anus, rectum or sigmoid.³

Criteria have been advanced to establish the independence of multiple primary neoplasms. Billroth postulated: (1) Each neoplasm must show independent histological characteristics. (2) Each neoplasm must rise from its parent epithelium. (3) Each neoplasm must produce its own metastatic lesions.

Mercanton added that if after removal of the two neoplasms the patient remains free of disease the independence of the tumors is assured.

The prerequisites of Warren and Gates were: (1) Each neoplasm must be malignant. (2) Each neoplasm must be distinct. (3) The second neoplasm cannot be a metastatic implant from the first.

When tumor occurs in a single group of cells its origin is unicentric. When several groups of cells give rise to more than one neoplasm it is of multicentric or pluricentric origin.³ Multiple cancers may be divided into two classes: (1) Synchronous, when they occur simultaneously, and (2) metachronous, when they occur at different times.⁷

CASE REPORT

R. K. Record No. 116091. A seventy-one year old white male was admitted October 17, 1940, with a four-day history of malaise, right lower quadrant pain and nausea. The pain was constant but there was no increase in severity. Although nausea was present the patient did not vomit. No abnormality of bowel function was noted. The patient had gained weight during the past two months. He had influenza in 1919, diabetes mellitus since 1925, Parkinsonism since 1925, and underwent prostatectomy in 1932.

Physical examination revealed an elderly, extremely nervous male, not acutely ill. His temperature was 98.4°F., pulse 96, respirations 20. The blood pressure was 190/94, heart not enlarged, rhythm regular, sounds of good quality and there were no murmurs. The chest was symmetrical and expansion equal. Lungs were resonant and breathing vesicular. There were no râles. The abdomen was symmetrical

* From the Surgical Service, New York Medical College, Flower and Fifth Avenue Hospital and Metropolitan Hospital. Dr. L. R. Kaufman, Director, New York, New York.

† Dr. Mersheimer is now on active duty with the Medical Corps of the United States Navy Reserve.

and a vertical midline scar (prostatectomy) was present. There was no distention. The abdomen was soft with slightly increased muscle tone

residue diet, colonics of 0.5 per cent sulfanilamide solution, intravenous fluids, vitamins and hematinics. Blood was banked for operation.



FIG. 1.



FIG. 2.

FIGS. 1 AND 2. Barium enema on October 18, 1940. Findings indicate two organic annular lesions, one at the junction of the descending and sigmoid colon and the second at the junction of the cecum and ascending colon.

over the right half and most pronounced in the right lower quadrant. Definite rebound tenderness was present in the right lower quadrant. A round, smooth, movable, slightly tender, hard mass about the size of an orange was palpated in the right lower quadrant. Normal peristaltic sounds were heard with the stethoscope. On rectal examination no intrinsic pathological disturbance could be palpated and the mass palpated abdominally could not be felt through the rectum.

The provisional diagnosis was: (1) carcinoma of the ascending colon, possible cecum; (2) possible appendiceal abscess; (3) Parkinsonism; (4) diabetes mellitus; (5) essential hypertension.

The abdominal pain subsided. On October 18th, a barium enema revealed constant irregularity and narrowing of the lumen of the colon at the junction of the descending and sigmoid colon. The mass in the right lower quadrant persisted and a second barium enema was done. The defect at the junction of the descending and sigmoid colon was again visualized. A second annular constriction was noted at the junction of cecum and the ascending colon. The findings indicated two organic annular lesions, one at the junction of the descending and sigmoid colon and the second at the junction of the cecum and the descending colon.

The patient was prepared for surgery by the usual routine which included a liquid non-

Celiotomy was performed on October 24th under cyclopropane inhalation anesthesia through a 15 cm. subumbilical left rectus incision. The stomach, liver and bile ducts, pancreas, spleen and kidneys were normal. There was no evidence of any metastasis. At the junction of the descending and sigmoid colon a hard constricting mass was palpated, the mass was about 8 cm. in diameter. The second mass was palpated in the ascending colon just above the ileocecal junction. It was about 12 cm. in diameter. The terminal ileum was divided 20 cm. proximal to the ileocecal valve and the ends inverted. A side-to-side anastomosis was performed between the ileum and the transverse colon. The lesion at the junction of the descending and sigmoid colon was mobilized by cutting the lateral peritoneal reflection, permitting the tumor to be exteriorized after the method of Mikulicz. The bowel was exteriorized through a small second incision in the left inguinal region. The left rectus incision was closed in layers.

The second stage was performed on October 28th at which time the exteriorized loop of colon with the tumor was excised with the cautery. Clamps were applied to the spur. The patient was having good bowel function through rectum by November 7th. The left rectus incision healed by primary union.

On November 14th, the third stage was performed under cyclopropane anesthesia through a 20 cm. right rectus incision. The previously closed stump of ileum was located. The terminal 20 cm. of ileum, cecum and appendix and the right half of the colon with the second tumor (to a point 5 cm. distal to the previously performed transverse ileocolostomy) was resected. The anastomosis was inspected and found to be well healed. There was no evidence of metastasis. The right rectus incision was closed in layers.

There were no postoperative complications and the right rectus incision healed by primary union.

There was persistence of the Mikulicz fistula and in spite of adequate breakdown of the spur there was still some abdominal drainage although the majority of bowel movements were entirely through the rectum. Plastic closure of the fistula was therefore proposed. A soft rubber rectal tube was passed through the rectum to a point 10 cm. above the fistula prior to operation. On January 13, 1941, the fistulous tract was excised and the colon closed by the usual procedure.

There was primary wound healing. Normal bowel movements occurred daily; the patient was ambulatory. After a short period of observation the patient was discharged on February 1st.

Patient was readmitted on July 22, 1941, at which time there was no clinical evidence of recurrence of the carcinoma. Reexamination of the colon by barium enema did not reveal any pathological condition. The patient was discharged on August 1st.

He was again readmitted November 1, 1941, and at this time barium enema showed a defect in the transverse colon which was suggestive of a polyp. The patient was discharged November 25th.

Following discharge from the hospital he returned to his home and apparently remained in good condition for several weeks. He then committed suicide and no autopsy was performed.

The pathological report on October 28, 1940, revealed the following:

There was a tumor mass from the descending and sigmoid colon. The specimen consisted of a section of the large bowel. On opening the bowel, there was a large cauliflower growth occupying the midportion of the bowel for a

distance of 6 cm. There was a hard thickening of the wall of the bowel with narrowing of the lumen. There was ulceration of the mucosa at this point. The mucosa on either side of the tumor was markedly edematous.

Microscopic examination revealed that there were large areas of neoplastic proliferation, polypoid in type with elongated glands lined by heteroplastic cells. The stroma was fibrotic with areas of lymphocytic infiltration. Sections of the terminal portions of the bowel showed no neoplastic tissue. Diagnosis: Polypoid adenocarcinoma of the descending and sigmoid colon.

On November 15, 1940, the resected terminal ileum and right colon was examined. The specimen consisted of the terminal ileum, cecum and appendix, and adjoining right colon. On opening the bowel there were several large cauliflower-like growths in the cecum and adjoining colon measuring 1 to 5 cm. in diameter.

Microscopic description was as follows: The intestinal mucosa showed neoplastic growth of polypoid appearance, papillary in type. The papillae were lined by several layers of anaplastic cells with many atypical mitoses and many hypersecreting mucous cells. Diagnosis: Papillary adenocarcinoma of the cecum and ascending colon.

Repeated urinalysis showed the urine to vary from light yellow to amber color, clear to slightly cloudy, with a hydrogen ion concentration of 5.5 to 7.5, specific gravity 1.014 to 1.022. On several occasions there were traces of albumin and sugar. At no time was acetone or diacetic acid present. White blood cells, red blood cells, epithelial cells and hyaline casts were occasionally present.

Blood counts: On October 17, 1940, the counts were as follows: hemoglobin 73 per cent, erythrocytes 3,920,000, leucocytes 11,250, mature polymorphonuclear leucocytes 63 per cent, immature polymorphonuclear leucocytes 5 per cent, lymphocytes 28 per cent, eosinophiles 3 per cent, monocytes 1 per cent. On November 3, hemoglobin 76 per cent, erythrocytes 4,430,000, leucocytes 14,300, polymorphonuclear leucocytes 84 per cent, lymphocytes 13 per cent, eosinophiles 2 per cent, basophiles 1 per cent. On January 12, 1941, the hemoglobin was 78 per cent, erythrocytes 4,500. Repeated blood sugar estima-

tions varied from 74 mg. to 108 mg. The Wassermann test was negative.

REFERENCES

1. COLE, W. H. and ELMAN, R. Text Book of General Surgery, 3rd ed. p. 696. New York, London, 1941. D. Appleton-Century Company.
2. OCHSNER, A. and DeBAKEY, M. Operability, morbidity, and mortality factors in cancer of the colon. *Am. J. Surg.*, 46: 103, 1939.
3. BACON, H. E. Multiple malignant tumors with involvement of the lower bowel. Report of multiple primary and contact growths. *Am. J. Cancer*, 35: 243, 1939.
4. RANKIN, B. A., BARGEN, B. S. and BUIE, B. A. The Colon, Rectum and Anus. Pp. 455-459. Philadelphia, 1935. W. B. Saunders Co.
5. MAJOR, R. H. Multiple primary malignant tumors: with report of a case of carcinomas and sarcomas in the same individual. *Bull. Johns Hopkins Hosp.*, 29: 223, 1918.
6. WARREN, S. and GATES, OLIVE. Multiple primary malignant tumors. A survey of the literature and a statistical study. *Am. J. Cancer*, 16: 135, 1932.
7. SCHWEIGER, L. R. and BARGEN, J. A. Multiple primary malignant lesions of the large bowel. *Arch. Int. Med.*, 66: 1331, 1940.



IN fractures of the spine it is important, as it is in extremity fractures, to restore the spine at once to correct length by suitable traction and manipulation, and to replace all the parts in correct anatomic relationship.

BRUCELLA SPONDYLITIS

CASE REPORT

MARTIN DOBELLE, M.D.

Staff Orthopedic Surgeon, House of Mercy Hospital

PITTSFIELD, MASSACHUSETTS

ALTHOUGH sixty-four cases of spondylitis complicating undulant fever have been reported to date, only three of the patients were treated by surgical fusion. The purpose of this communication is to add the sixty-fifth case and the fourth one in which operative fusion was employed. Mazzocchi states that it is necessary to make a most thorough study in the differential diagnosis. This case bears out the wisdom of such advice.

CASE REPORT

In December, 1939, A. W., a twenty-three-year old *farmerette* in the fourth month of pregnancy (primipara), stooped to lift a small child when she felt a painfully sharp "click" in the lower portion of her back. The pain persisted and her family physician advised that its cause was undoubtedly the excessive weight of the embryo. In May, 1940, however, a normal, full term infant was delivered without the expected relief from pain. Actually, the pain became progressively worse until at the end of three months, the patient could endure it no longer and her physician referred her to an orthopedist for extensive roentgenologic examination.

On the basis of the roentgen findings and a positive (?) Vollmer patch test, a diagnosis of tuberculous destruction of the fourth lumbar vertebra was made. (Fig. 1.)

The patient was institutionalized in a tuberculosis sanitarium where she remained recumbent for five months in a double-leg spica jacket. While there, additional roentgen study was undertaken and on one of the films, a psoas bulge was visualized. A trocar was introduced in order to aspirate the swelling, but during the procedure, the instrument broke at its hilt. To remove the imbedded portion, formidable surgical intervention was necessary.

The purulency obtained cultured sterile, as is not infrequent in a "cold (tuberculous or brucellosis) abscess"; in spite of diligent search, however, at no time had there been found any evidence of tuberculosis. Finally, in December, 1940, the patient was discharged home, recumbent in a bivalved double-leg spica jacket with a most actively draining sinus in the left groin.

I saw her for the first time in January, 1941, and while I was delving into her past history, the patient recalled (*for the first time*) that in January, 1939, about one year prior to onset of back symptoms, she had experienced a high, *unexplainable temperature* for a period of ten days, following which recovery was apparently complete.

Blood titers for undulant fever were now advised and done; the concentration from the State laboratories proving to be 1:1000 in 1,024.

The patient was then transferred from her home to a hospital in Pittsfield, Massachusetts, where the persistent sinus was treated locally (ether, Petroff's iodine solution, etc.) but without success. As her temperature continued to fluctuate, it seemed advisable to administer an intensive course of sulfanilamide. This was done with the result that the temperature subsided.

Meanwhile, however, serial roentgenograms (Figs. 2 and 3) had revealed a rapidly progressive destruction of the fourth lumbar body with suspicious involvement of the third, and early neurologic symptoms, viz. root pain, etc.

In view of these findings, I deemed it advisable that a spine fusion be attempted before the posterior elements with total collapse ensued. Consequently, on February 21, 1941, a spine fusion was undertaken, extending from the third to the fifth lumbar body inclusive, adhering to the Hibbs' technic, overlaid by an osteoperiosteal graft from the tibia. At the time of surgery, if the posterior element involvement had been suspected, fusion would



FIG. 1. Area of destruction is faint though readily discernible.



FIG. 2. Destruction area is now larger and more circumscribed. The joint space between the fourth and fifth lumbar, has become narrower with a corresponding widening of the joint space between the third and fourth lumbar.



FIG. 3. Destruction is progressive, the area is beginning to crumple and encroach posteriorly.



FIG. 4. Fusion area is solid and previously necrotic area is healed.

have been extended to the sacrum. The incisional wounds healed per primum and the patient's postoperative course was uneventful.

Eight weeks later, after the patient had been removed from her recumbent plaster of paris shells and a snug-fitting body jacket had been applied, she was discharged home comfortably ambulant. Her convalescence continued uneventfully for six months after leaving the hospital, the groin sinus healing in the interim.

Then, suddenly, the patient's temperature rose to 105.2°F. with pain in the groin *opposite* the now healed sinus. Examination revealed a fluctuant mass, the size of an orange.

This was incised and drained, with the evacuation of about 100 cc. of thick, greenish-tinged purulence, after which the patient's temperature dropped to normal and she became symptom free. This purulency, like the first, cultured sterile. For a while both sinuses would drain at intervals until eventually, they would close over and remain closed for several days, with an accompanying rise of temperature and abdominal distress. As long as either sinus drained, she was entirely comfortable and symptom free. Repeated blood titers indicated that a positive agglutination persisted. The roentgenograms revealed definite healing of the fourth lumbar body with no right or left psoas bulge.

Communication was now made with the laboratories of the Michigan State College, Central Brucella Station, and, following a course of brucellin therapy, which was administered for four months in accordance with suggested directions, the sinuses stopped draining and promptly healed, after which the patient experienced no further abdominal distress.

Six months after the discontinuance of brucellin, the blood titer continues to be negative, the patient remaining symptom-free and perfectly comfortable. A recent roentgenogram (Fig. 4) of the spine revealed a solid fusion area with a healed fourth lumbar vertebra.

CONCLUSIONS

1. A case of spondylitis complicating undulant fever wherein surgical fusion was successfully employed is presented.

2. Brucellin proved to be a most valuable adjunct.

3. Had not the differential diagnosis been established when it was, fusion might have been performed too late for the patient's benefit.

4. Therefore, the early differential diagnosis in cases presenting a similar clinical picture is urged.

REFERENCES

1. BENASSI, E. Sull'aspetto radiologico e sulla fisioterapia delle artriti e spondiliti da febbre undulante. *Radio. Med.*, 23: 686, 1936.
2. BISHOP, W. A., Jr. Vertebral lesions in undulant fever. *J. Bone & Joint Surg.*, 21: 3, 1939.
3. CATELLI, F. Spondilite da brucellosi. *Rassegna internaz. di clin. e terap.*, 15: 649, 1934.
4. CIMINO, S. Sulla spondilite melitense. *Riv. San. Siciliana*, 22: 1077, 1934.
5. CLERICI, CARLO. Spondylitis in Malta fever. *Gior. di Clin. Med.*, 13: 2-25, 1932.
6. CRAIG, C. F. The symptomatology and diagnosis of Malta fever, with the report of additional cases. *Internat. Clin.* 14: 89, 1906.
7. DELIHERM, L. ESTEVE; et MORICE: Contribution a l'etude de la melitococcie osseuse. *Bull. et mem. Soc. de Radiol. Med. de France*, 24: 814, 1936.
8. FELDMAN, W. H. and OLSON, CARL, JR. Spondylitis of swine associated with bacteria of the brucella group. *Arch. Pathol.*, 16: 195, 1933.
9. GAUTIER, M. Spondylite melitococcique. *Lyon Med.*, 155: 257, 1935.
10. GOLDFAIN, E. Studies in 80 arthritic cases associated undulant fever findings. *South. M. J.*, 31: 325, 1938.
11. HARDY, A. V., JORDON, C. F., BORTS, I. H. and HARDY, G. C. Undulant fever with special reference to a study of brucella infection in Iowa. *National Inst. Health Bull.*, No. 158, Dec., 1930.
12. HARRIS, HAROLD J. Physical therapy of various manifestations of brucellosis (undulant fever). *Arch. Phys. Therapy*, 21: 605, 1940.
13. IZAR, G. and MORETTI, P. Action of short waves on course of brucella abortus infection. *Klin. Wchnschr.*, 14: 46, 1935.
14. KRUSEN, FRANK H., PHALEN, GEORGE S. and PRICKMAN, LOUIS E. Brucellosis spondylitis. *J. A. M. A.*, 118: 859, 1942.
15. KULOWSKI, JACOB. Undulant (Malta) fever osteomyelitis and arthritis. *Surg., Gynec. & Obst.*, 62: 759, 1936.
16. KULOWSKI, JACOB, and VINKE, T. H. Undulant (Malta) fever spondylitis. Report of a case, due to brucella melitensis, bovine variety, surgically treated. *J. A. M. A.*, 99: 1656, 1932.
17. MAZZOCCHINI, A. Observations in a case of vertebral localization in Malta fever. *Gazz. internaz. med.-chir.*, 46: 438, 1936.
18. O'DONOGHUE, A. F. Septic arthritis in the hip caused by brucella melitensis. *J. Bone & Joint Surg.*, 15: 506, 1933.

19. PALAGI, PIERO. Le localizzazioni vertebrali nella febbre ondulante. *Chir. d. Org. di Morimento*, 20: 31, 1934.
20. PRATESI, F. Lesioni vertebrali in brucellosi. *Gior. di Clin. Med.*, 17: 623, 1936.
21. PRICKMAN, L. E. Treatment of brucellosis by hyperpyrexia induced by the Simpson-Kettering hypertherm. *Proc. Staff Meet., Mayo Clin.*, 11: 506, 1936.
22. PRICKMAN, L. E., BENNETT, R. L. and KRUSEN, F. H. Treatment of Brucellosis by physically induced hyperpyrexia. *Proc. Staff Meet., Mayo Clin.*, 13: 321, 1938.
23. PUIG, R. Diagnostic de l'osteo-arthrite vertebrale melitococcique. *J. de Med. et Chir. Prat.*, 107: 617, 1936.
24. ROGER, HENRI. Fievre de Malte. *Gaz. d. Hôp.*, 83: 113, 1910.
25. ROGER, H. PAILLAS, J. and FARNARIER, G. Spondylite melitococcique avec radiculonevrite sciatique. *Marseille Med.*, 1: 668, 1937.
26. SANDSTROM, O. Multiple spondylitis bei febris undulan bang. *Acta Radiol.*, 18: 253, 1937.
27. SERIO, F. Sulle spondiliti melitococciche. *Arch. di Pat. e Clin. Med.*, 6: 247, 1927.
28. SIMPSON, W. M. Undulant fever (brucelliasis). A clinicopathologic study of ninety cases occurring in and about Dayton, Ohio. *Ann. Int. Med.*, 4: 238, 1930.
29. SNYDER, C. H. Spondylitis in undulant fever. A report of two cases. *J. Michigan State Med. Soc.*, 34: 224, 1935.
30. STRACHAN, P. D. Bone abscess following undulant fever. *Brit. M. J.*, 2, 271, 1932.
31. ZEITER, WALTER J. Treatment of undulant fever by artificial fever therapy. Report of case. *Cleveland Clin. Quart.*, 4: 309, 1937.



Two common causes of disability following injuries to the foot are: failure to recognize fractures with minor deformities, and failure to protect the foot by special shoes and braces against further damage by weight-bearing afterward.

CAVERNOUS HEMANGIOMA OF THE SKULL*

CASE REPORT

DEAN H. ECHOLS, M.D.

Assistant Professor of Surgery in Charge of Neurosurgery, Tulane University School of Medicine

AND CAPT. L. R. J. KLEINSASSER, M.C.

United States Army

NEW ORLEANS, LOUISIANA

HEMANGIOMAS are tumors composed of newly formed blood vessels. Such growths may be cavernous or capillary in type and, when they

sporadic references to the condition have appeared in the literature. In 1930, Bucy and Capp,² in a review of the literature, found eighteen cases of angioma of the



FIG. 1. A and B, preoperative and postoperative photographs of the patient.

occur in bone, are more often found in the cranium and spine than in other parts of the skeleton. They are usually benign and may or may not cause symptoms. In the case of cranial hemangiomas their growth is gradual and as they increase in size, headaches, vomiting and even convulsions may be experienced. A definite diagnosis can be made from the characteristic "sunray" appearance seen in the roentgen ray films. Operative removal of the tumor, when possible, offers the best results.

The disease is rare. Since Toynbee¹ first described an angioma of the skull in 1845,

skull in fifty-six cases of hemangioma of bone. Seven years later, Anspach³ was able to collect twenty-one cases of hemangioma involving the skull and reported a case of his own. The most recent review of the literature by Abbott,⁴ in 1941, reveals only twenty-six reported cases of angioma of the skull. He presents an additional case and since his review, one more case has been recorded.⁵ These, together with the one we are presenting, bring the total number of reported cases to twenty-nine.

The following case of cavernous hemangioma of the right frontal bone, including

* From the Tulane University School of Medicine and Charity Hospital, New Orleans.

the superciliary arch and orbital plate, is reported not only because of the rarity of the condition but also because it has

areas on its surface. No subjective symptoms were experienced until three years before admission when the patient complained of



FIG. 2. A and B, preoperative roentgenogram showing the "sunray" appearance of the tumor and postoperative roentgenogram showing the defect after removal.

been stated³ that operation on hemangioma this size would be fatal.

CASE REPORT

E. H., a colored farmer, aged forty-seven, entered Charity Hospital in New Orleans, March 3, 1941, because of a large tumor of the forehead causing intermittent aching pain. About twelve years before admission he noted

intermittent aching pain in the tumor, particularly at night.

Situated over the right side of the forehead, the mass projected like a horn. (Fig. 1A.) It was smooth on its surface, dome-shaped and extended from the eyebrow to a point 6 cm. behind the hair line, being entirely to the right of the midline. The skin encasing the mass was freely movable. No pulsation was noted. The mass was 27 cm. in circumference at the base and 21 cm. near the apex. The mass was firm and bony at the base and soft at the apex with areas of firmness interspersed. In the right temporal region were two dilated veins, but no bruit was heard over the tumor.

Roentgenograms (Fig. 2A) showed a tumor with perpendicular striations arising from the right frontal bone. There was involvement of the superciliary arch and the roof of the orbit. A diagnosis of hemangioma of the skull was made.

On March 12, 1941, under a local anesthetic a sagittal incision was made over the tumor beginning just above the supra-orbital margin. The two flaps of skin were dissected free from the tumor. The periosteum and temporal muscle were incised around the base of the tumor with the electrosurgical knife. A single trephine was made in the skull. With this as a starting point a groove 1 cm. in width was made with a rongeur around the base of the tumor. It was necessary to remove parts of the superciliary ridge and roof of the orbit. Bleeding from bone was controlled by application



FIG. 3. Bisected specimen. The large white areas are pieces of skull. The intra-cranial portion of the tumor is much smaller than the extra-cranial portion.

a smooth, round, hard growth about the size of a pea on the right side of his forehead. For seven years the mass gradually and uniformly increased in size until it became as large as a pecan. For the next four years it grew rapidly. Since then there has been little change. The tumor was not uniformly hard but had soft

of wax. The tumor (Fig. 3) was separated from the underlying dura with the finger and lifted off in one piece. The dura was not torn during this procedure. The frontal sinus, which

(Fig. 2B.) Convalescence was uneventful. (Fig. 1B.)

Pathologic examination of the mass revealed a firm, encapsulated tumor measuring 12 cm.

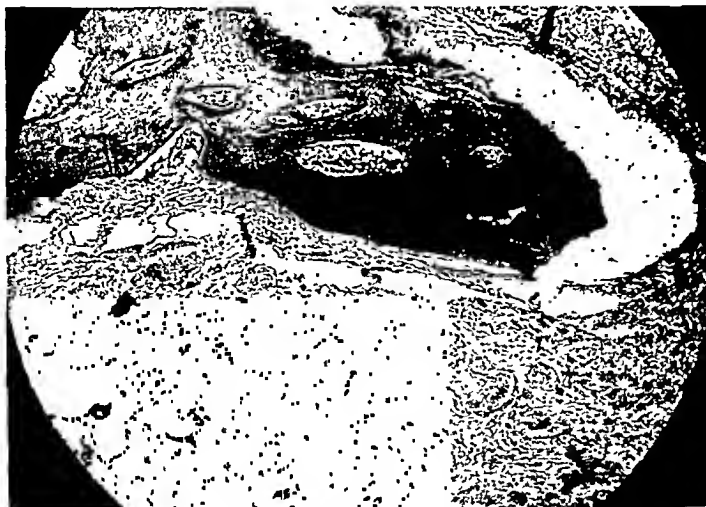


FIG. 4. Microphotograph showing typical cavernous hemangioma. The darker area is a spicule of bone.

had been widely opened, was closed by suturing the periosteum to the dura. The tumor mass had extended inward as well as outward and had greatly depressed the dura and the underlying frontal lobe. While preparation was being made for closure of the skin, it was noted that the redundant dura had completely expanded, indicating an acute subdural hematoma. The dura was opened and the large fresh clot was removed. The surface of the brain appeared normal except that it was flattened and depressed. The bleeding vessel which had produced the subdural hematoma was grasped with a forceps and electrically coagulated. The incision in the dura was sutured to the periosteum at various points and the skin closed in layers. A drain was left in the wound for twenty-four hours because of the impossibility of obtaining complete hemostasis. The blood loss was considerable but did not fulfill expectations and replacement measures were entirely adequate. There was no shock during or after operation. A postoperative roentgenogram showed the defect in the bone.

by 10 cm. by 8.5 cm. and weighing 360 Gm. It consisted chiefly of hemorrhagic tissue. The microscopic diagnosis was cavernous hemangioma of the skull. (Fig. 4.)

Fifteen months after operation, on June 19, 1942, the patient was requested to return for re-examination. There was no evidence of recurrence of the tumor at this time. There were no complaints. On close questioning, however, he stated that he no longer worked on his farm at noon on hot days because giddiness resulted.

REFERENCES

1. TOYNBEE, J. An account of two vascular tumors developed in the substance of bone. *Lancet*, 2: 676, 1845.
2. BUCY, P. C. and CAPP, C. S. Primary hemangioma of bone. *Am. J. Roentgenol. & Rad. Therap.*, 23: 1, 1930.
3. ANSPACH, W. E. Sunray hemangioma of bone with special reference to roentgen signs. *J. A. M. A.*, 108: 617, 1937.
4. ABBOTT, W. D. Angioma of the skull. *Ann. Surg.*, 113: 306, 1941.
5. KAPLAN, A. and KANZAR, M. Sunray hemangioma of the skull. Report of a case. *Arch. Surg.*, 39: 269, 1939.



EXCISION OF THE DUODENUM AND HEAD OF THE PANCREAS FOR CARCINOMA OF THE AMPULLA

METHOD OF ANASTOMOSING PANCREATIC DUCT TO THE JEJUNUM

JOHN ROBERTS PHILLIPS, M.D.
Diplomate of the American Board of Surgery
HOUSTON, TEXAS

RADICAL surgery for carcinoma of the ampulla or head of the pancreas has now taken its place in their management. In a recent communication from Whipple he states that the case that I am reporting brings the total number of cases that have appeared in the literature, or have been reported to him, to about sixty-five, who have had radical surgery for carcinoma of the ampulla or head of the pancreas.

This patient presented an unusual problem in that upon his admission, he had evidence of an acute cholecystitis with a perforation of the gallbladder. At operation it was found that he had a gangrenous gallbladder, which had ruptured and bile ran free in the peritoneal cavity. There was a small liver abscess about two inches from the gallbladder. Everything was so indurated that nothing further than a cholecystostomy and a drainage of the liver abscess was carried out. There were no stones in the gallbladder. After a rather stormy course, his general condition improved. He was in the hospital about three weeks, during which time all of the bile drained out his cholecystostomy wound. No bile, whatever, went through to his duodenum. There was a lot of infection in his abdominal wall, which slowly subsided and after two months he was in such condition that it was decided that exploration of his biliary tract could be carried out. He was explored with a provisional diagnosis of a common duct stone obstructing the ampulla of Vater.

At operation the common duct was markedly dilated. It was opened and upon passing a scoop down to the ampulla, a soft mass could be felt, which was about the size of the end of the little finger. It felt like a soft stone, but nothing could be milked back. Because of this, the duodenum was then opened over the

ampulla and a tumor mass could be seen. A section of this was taken and reported to be a Grade 2 adenocarcinoma. The tumor was destroyed by cautery and the duodenum closed. The common duct was then anastomosed to the stomach above the pylorus and the gallbladder removed, because it was so badly diseased that it could not be used in anastomosis. An anterior gastroenterostomy with an entero-anastomosis was made, the anterior operation being necessary because of adhesions and induration in the transverse mesocolon. The abdomen was drained. The patient, this time, made a very rapid and had a very easy convalescence. He was in the hospital about twelve days.

He, again, had a good deal of infection in his abdominal wall, so that the operation of radical excision had to be postponed again for six weeks. At the end of this time he was re-explored and the duodenum with the entire head of the pancreas was removed in one block. The pyloric end of the stomach was closed, as was the cut end of the duodenum near the ligament of Treitz. The pancreatic duct was ligated and the head of the pancreas was sutured with linen. A catheter was left into the raw bed and the space was further drained by a Penrose drain. He was given a blood transfusion on the operating table. The operation was unusually difficult because of the many adhesions and because of the persistence of a good deal of induration in the tissues. He stood the operation well. On the fourth post-operative day he developed a pancreatic fistula. For the first two days he drained 360 cc. Following that it decreased rather rapidly until at the end of the ninth day there was only 50 cc. drainage. This had completely stopped by the twelfth day, at which time he was allowed to go home from the hospital.

The functioning of the gastroenterostomy and the anastomosis of the common duct to

the stomach had been perfectly normal in every respect. There has been no jaundice and there has been no gastric retention. He is

and they have not been fatty. It has been the experience of Whipple that these patients are able to digest 80 to 85 per cent of a meas-

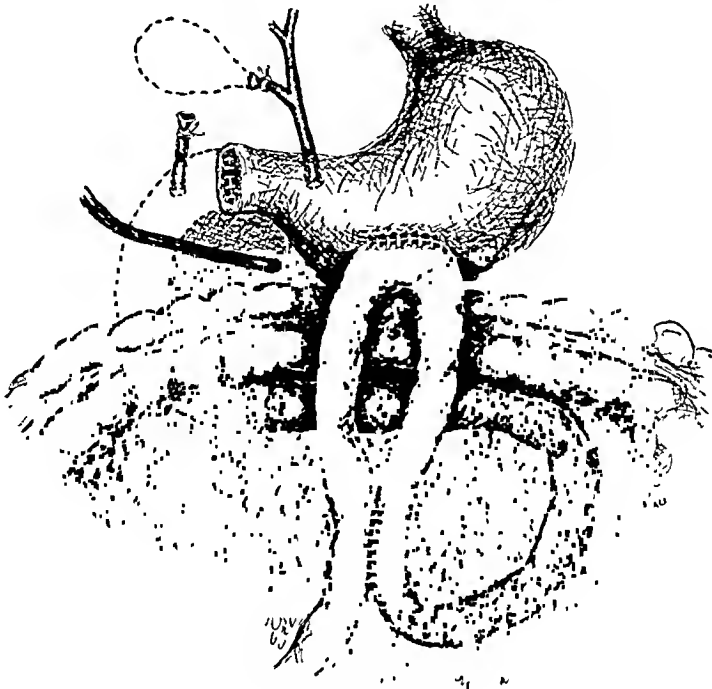


FIG. 1. Shows the method of handling the common duct in the case reported.

eating well and feels fine at this time. He was strong enough to report to the office for dressing

ured fat intake. In some cases, however, pancreatic extract and lipocaic have to be administered. This is particularly true if there are fatty bulky stools.

The pathological examination of the specimen revealed an ulcerating carcinoma at the ampulla, a centimeter in diameter. There was infiltration of all the layers of the duodenal wall. There was no infiltration into the pancreas and there was no lymph gland involvement found. It was diagnosed adenocarcinoma, Grade 2. Due to the fact that this man is forty-four years of age and that he had a small lesion, it is hoped that he might be able to survive for a long time so that the effect can be studied throughout the course of several years.

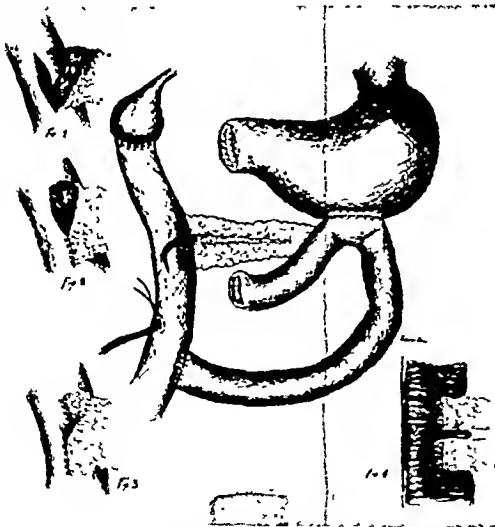


FIG. 2. Shows the proposed method of handling the pancreatic duct.

on the seventeenth postoperative day. There has been no interference from the loss of the pancreatic secretion. The bowels are normal

Prior to Whipple's advocacy of radical surgery for lesions in this area, only palliative procedures had been carried out. I was unable to carry out the procedure as advocated by Whipple due to the condition of the gallbladder and I realize that the operation of anastomosing the gallbladder

to the jejunum is a more scientific procedure. Due to the serious biliary fistulas that often develop after ligation of the common duct, Whipple now anastomoses the common duct to the jejunum. This is even a better procedure.

PROPOSED METHOD OF HANDLING PANCREATIC DUCT

Up to the present time the pancreatic duct has been ligated and dropped back. Whipple has anastomosed it to the posterior wall of the stomach. In the future I believe that it will be worth considering, and I plan to utilize this method of using a rather long loop of jejunum to anastomose to the common duct as a first stage. In this way the loop, after extirpation of the duodenum and head of the pancreas, can be swung over against the neck of the pancreas and the neck of the pancreas literally inserted into the side of the jejunum. In this way the loss of pancreatic digestion will not be complete, and in order to afford better healing of the pancreas

to the side of the jejunum, I propose to insert a duodenal tube through the jejunum below the site of anastomosis, stitch the tube into the pancreatic duct and after returning the patient to the room, start suction, using the Wangenstein apparatus. This should keep the pancreatic and biliary secretions away from the area of anastomosis and allow healing to take place. In about a week or ten days this catgut suture should slough out and the tube then can be removed.

Carcinomas of the ampulla of Vater should be more favorable than carcinomas of the head of the pancreas for radical surgery for they metastasize more slowly. These lesions are often very small and unless at exploration the duodenum is opened and a biopsy taken, many operable lesions will probably be overlooked. I am sure that in my case I would have entirely missed the diagnosis, had I not opened the duodenum and taken a specimen for microscopic study. I urge that this be done in all doubtful cases.



PEDUNCULATED OVARIAN CYSTS IN CHILDREN

AN AID TO DIAGNOSIS

L. M. RANKIN, M.D.

AND

S. A. EGER, M.D.

Chief of Surgical Service, Delaware County Hospital

Assistant Surgeon, Delaware County Hospital

UPPER DARBY, PENNSYLVANIA

AFTER reviewing the literature Benjamin found that only 120 cases, including his own, of ovarian cyst

ligament and the uterus and can be plainly felt by the finger palpating the cervix. This shows that the mass in question is attached to the uterus or adnexa and thus differentiates it from other conditions with which it might be confused and which rarely have such a pelvic attachment.

The following case illustrates the value of this maneuver:



FIG. 1. Dermoid cyst showing pedicle removed from girl age nine years.

with torsion of pedicle in children had been reported up to 1940, and that the majority of these were erroneously diagnosed preoperatively as appendicitis with abscess formation. He further states that the majority of the cases of torsion occurred on the right side which might account for the error in diagnosis.

We have found that a reverse bimanual abdominorectal examination has been extremely helpful in the problem case. This is performed as follows: With the index finger of one hand palpating the cervix through the rectum, the other hand pushes the movable ovarian cyst upward toward the diaphragm as far as it will go to produce tension on the pedicle. At this point, tug-like pushes against the cyst will be transmitted along the pedicle to the broad

A nine year old female was admitted to the surgical ward of the Delaware County Hospital in Drexel Hill, Pennsylvania, on November 13, 1938, with a diagnosis of appendiceal abscess. For several years she had complained of brief pains in the lower part of her abdomen, not associated with any other symptoms. There had also been some frequency of urination. About seven hours before admission the patient developed lower abdominal pains, chiefly on the right side. The pain continued intermittently. Nausea and vomiting followed the pain. The patient had had scarlet fever at four years, whooping cough at six, tonsillectomy and adenoidectomy at six and measles and mumps at eight. Her father and mother were living and well. On admission the patient's temperature was 99.3°F., pulse 100 and respirations were 22. Leukocyte count showed 12,100 white cells, 64 per cent polymorphonuclears, 35 per cent lymphocytes, 18 per cent stabs and 46 per cent segmented. Urine was negative except for a trace of albumin and a plus one acetone. Complete physical examination was negative except for the abdomen. Abdominal examination revealed slightly spastic muscles in the lower right quadrant; there was no distention or free fluid and peristalsis was apparently normal. In the lower right quadrant could be palpated a tense, tender, globular mass, smooth and regular in outline, about four inches in diameter which could be freely moved, without additional discomfort to the patient, downward into the pelvis and upward

in the midline to the level of the umbilicus. Using the reverse abdominorectal examination described above, a definite diagnosis of ovarian cyst with torsion of the pedicle was made. At operation this was verified when a cyst of the right ovary with one and one-half turns of the pedicle was found and removed. The pathologist reported a dermoid cyst of the ovary. The patient made an uneventful recovery and was discharged as well on November 26, 1938. Since then there has been no recurrence of symptoms.

CONCLUSION

1. Partly because of its rarity, ovarian cyst with torsion of the pedicle in children is difficult to diagnose.
2. A method of reverse abdominorectal examination is described which has proved helpful in diagnosing this condition.

REFERENCE

- BENJAMIN, D. Torsion of ovarian cysts in children: report of case with recovery. *Am. J. Surg.*, 53: 500, 1941.



WHETHER the fracture of the calcaneum is simple or compound we should always secure and maintain correct length and position by a traction pin through the back of the calcaneum and a pin through the tibia above, both firmly immobilized in the plaster-of-paris cast until the fracture has healed.

RUPTURE OF THE NORMAL CECUM RESULTING FROM MALIGNANT OBSTRUCTION OF THE SPLENIC COLON*

GILBERT B. TEPPER, M.D. AND THEODORE B. MASSELL, M.D.

LOS ANGELES, CALIFORNIA

RUPTURE of the distended but otherwise normal cecum is mentioned in textbooks as a possible complication of large bowel obstruction, yet reports of such cases are surprisingly rare in the surgical literature. In American journals the last report of specific occurrences of this type was in 1935 by Saeltzer and Rhodes.¹ These authors cited only two other case reports by American observers in two previous decades, respectively: Hartwell in 1917² and Dickenson in 1922.³

While any part of the large bowel may perforate at the site of an ulcerative lesion such as carcinoma, tuberculosis, regional colitis, typhoid fever, etc., rupture of the normal colon as a result of overdistention apparently occurs only in the cecum. There are several reasons why the latter rather than any other portion of the large gut tends to give way:

1. In those patients in whom the ileocecal valve is competent, the colon is converted by an obstructing lesion into a closed system in which the internal pressure is equal throughout. Although the pressure is the same in all parts of this system in accordance with physical laws, the force or tension against the wall varies in proportion to the square of the radius. The cecum having a larger diameter than any other part of the large intestine, is exposed to a greater bursting force. The tension against the cecal wall would be four times as great as in some other part of the colon whose lumen were half as large.

2. The wall of the cecum is normally thinner than that of any other part of the large bowel. This difference in thickness is often accentuated by the hypertrophy of bowel wall that occurs while obstruction is still incomplete. The thickening of the

colon wall is greatest just proximal to the site of the obstructing lesion, gradually decreasing with distance from the obstruction and is thus minimal in the cecum.

3. When a loop of bowel first becomes obstructed, the intraluminal pressure causes obstruction of the blood supply in the intestinal wall resulting in an ischemic state which is relieved by gradual stretching of the smooth muscle of the wall until the pressure within is diminished. The wall of the cecum is thin, inelastic, and under the greatest tension. It is probable that the cecal wall is often not elastic enough to relieve the pressure from within so that ischemia is prolonged and leads to small areas of necrosis. It is through such necrotic areas that perforation occurs.

Saeltzer and Rhodes¹ suggested the origin of cecal rupture in avascular necrosis and advanced confirmatory evidence from their observations. (1) Not infrequently there have been several openings in the cecum instead of one single opening. If rupture resulted from simple bursting due to pressure, the occurrence of one rent would release the pressure at once and prevent perforation at other points. (2) Most cecal perforations are found not where the wall is weakest but where the blood supply is poorest. Harris⁴ demonstrated that the mesial aspect of the cecum, just above the ileocecal valve, is mechanically the weakest area, yet most perforations occur along the anterior surface. This is the antimesenteric border, hence least vascular. That was the site of rupture in the following case.

CASE REPORT

On July 31, 1941, a sixty-nine year old male was admitted to the Queen of Angels Hospital

* From the Department of Surgery, Ross-Loos Medical Group, Los Angeles, California.

with the complaint of cramp-like pains in the lower abdomen of three days duration, associated with increasing abdominal distention and vomiting of gastric contents. He had had no abnormal stools, diarrhea, tenesmus or weight loss, but during the preceding several months, chronic constipation, present for years, had become progressively worse. There had been no satisfactory bowel movement for more than a week but there was still some passage of flatus.

Examination revealed a dehydrated elderly male with a tense, distended, tympanitic abdomen. The lower portion of the abdomen was somewhat tender throughout without any definite localization. Peristalsis appeared accentuated. No masses were felt. The hemoglobin and red cell count were slightly increased while the white cell count was 4,400 with normal differential. The urine contained a trace of albumin, acetone bodies and a few red and white cells. A plain roentgenogram of the abdomen revealed distended bowel loops in a pattern consistent with obstruction in the descending colon.

A soap suds enema given on admission yielded good fecal and flatus results, but subsequent enemas were ineffective. The patient refused operation at first but progressive deterioration of his condition and continued pain led him to change his mind after three days. At this time, the abdomen seemed more tense and distended, peristalsis was no longer audible and the pain had become constant instead of cramp-like in nature. The pulse rate had increased from 86 shortly after admission to 118 on the morning of operation and the patient's condition was obviously very poor.

Operation was performed on August 2, 1941, by Dr. Tepper. The initial incision revealed a diffuse foul smelling peritonitis which had apparently originated from a small perforation in the cecum. The opening was in the center of a rounded necrotic area about 1 cm. in diameter on the anterior wall of the cecum. All visible loops of small intestine, the cecum, and the ascending colon were markedly distended. A tube cecostomy was performed in the area of the perforation taking care to carry the purse-string sutures well out into the healthy bowel. Sulfanilamide was placed in the peritoneal cavity and in the layers of the operative incision.

Postoperatively, the patient became progressively worse with early signs of bilat-

eral bronchopneumonia and terminal jaundice. Throughout the postoperative period, the cecostomy functioned well and the patient's distention decreased somewhat. Death occurred four days after operation.

At autopsy an obstructing adenocarcinoma was found at the splenic flexure of the colon. The rest of the large bowel including the region of the cecostomy was normal. Death was due to bronchopneumonia and parenchymatous degeneration of the liver.

CONCLUSIONS

Both in location and appearance the perforation in this case seemed to have resulted from local ischemia and gangrene rather than from tearing or bursting caused by pressure alone. The rupture probably took place during the period of delay caused by the patient's initial refusal of operation, yet there was no sudden dramatic picture such as is usually seen when a hollow viscus perforates.

The clinical signs did not at any time suggest a pathological process involving the cecum or appendiceal region. Some writers, however, have stated that the clinical picture in this situation may resemble acute appendicitis with perforation. The early picture in this case was that of large bowel obstruction but later signs were suggestive of a superimposed peritonitis.

Perforation of the cecum is one of the complications which may occur when operation is delayed in cases of large bowel obstruction. The rarity of this condition in recent years probably is due to the better treatment of intestinal obstruction which characterizes modern surgery.

SUMMARY

Rupture of the normal cecum may occur rarely as a result of obstruction of the colon distal to the cecum. A case report has been presented with a discussion of the probable mechanism.

REFERENCES

1. SAELTZER and RHODES. *Ann. Surg.*, 101: 1257, 1935.
2. HARTWELL. *Ibid.*, 66: 339, 1917.
3. DICKENSON. *J. A. M. A.*, 78: 1792, 1922.
4. HARRIS, F. I. Personal communication to Saeltzter et al. (cited by them).

MULTIPLE ARGENTAFFINOMAS IN ILEUM WITH METASTASES IN LYMPH NODES AND IN THE LIVER*

I. ROY GOLD, M.D.†

AND

DAVID M. GRAYZEL, M.D.

Assistant Resident in Gynecology, The Jewish Hospital
of Brooklyn

Associate Director of Laboratories, The Jewish Hospital
of Brooklyn

BROOKLYN, NEW YORK

GOSSET and Masson are the authors of our present day concept of those small, often multiple tumors of the gastrointestinal tract to which they gave the name "argentaffinoma." The literature is a reminder, however, that Lubarsch first described and recognized these tumors as being unusual, as far back as 1888. Ranson, in 1890, reported a small neoplasm in the submucosa of the ileum which had extended into the mesentery and through the peritoneum and secondarily involved the liver. The description corresponded to the picture associated with the argentaffin tumor but was considered by him as carcinoma. Obendorfer first suggested that they may arise from pancreatic rests but later demonstrated the chromaffic nature of the cells. Because of its similarity morphologically to carcinoma and its relative benignity he applied the term "carcinoid" to these tumors. Not one of his six cases of multiple tumors of the small intestine showed any evidence of local extension or distant metastases and all grew slowly. Krompecher and Bunting concluded they were related to the basal cell carcinomas. Forbus, in a thorough survey of the subject in 1925, was likewise impressed with their relative benignity and their possible endocrine origin. That they may often be malignant, has become more evident in reports of these tumors of late years. Obendorfer, in 1929, reported four cases in the ileum with metastases. Cook, Humphreys, Cameron, Möhl, and Wyatt all discussed their potential malignancy and added cases in support. Willis recently pointed to their malignant and metastatic

propensities and reported six cases, in three of which he observed distant metastases. In a survey of the literature, Wyatt could find 159 cases of argentaffinoma in thirty-two of which there were metastases only to the regional lymph nodes and thirteen to more distant areas, chiefly the liver. This would indicate metastases in 28 per cent of all cases reported.

Masson clearly demonstrated that the silver reducing properties of the tumor cell coincided with those seen throughout the gastrointestinal tract in the Kulchitzky cells at the base of the crypts of Lieberkuhn. These reducing properties, he pointed out, corresponded to the functional state of the argentaffin cells and as a result some tumors could be completely free from them.

It is interesting to note that argentaffinomas occur most frequently where the Kulchitzky cells are normally found most abundantly. Thus the appendix and ileum are by far the commonest sites. They occur oftenest in the tip of the appendix and are approximately five times as common there as in the ileum. Humphreys found that about 30 per cent of those found in the small intestine were multiple. They are most often found incidently at autopsy or at operation, but the symptoms when they are present are referred to the appendix or intestine. Those in the small bowel rarely grow sufficiently large to cause obstruction by themselves but mesenteric metastases may give rise to adhesions or volvulus with resultant symptoms of intestinal obstruction.

Macroscopically, they appear to arise from the submucosa or mucosa, are firm,

* From the Department of Laboratories, The Jewish Hospital of Brooklyn, Brooklyn, New York. † Dr. Gold is now on active duty as a First Lieutenant in the Medical Corps, A. U. S.

or rubbery in consistency, usually do not lead to ulceration of the mucosa, and most frequently vary in size from 0.5 cm. to

are functionally active acidophilic granules are seen which reduce the silver salts after the method of Masson. This author be-



FIG. 1. Photograph of argentaffinomas in ileum.

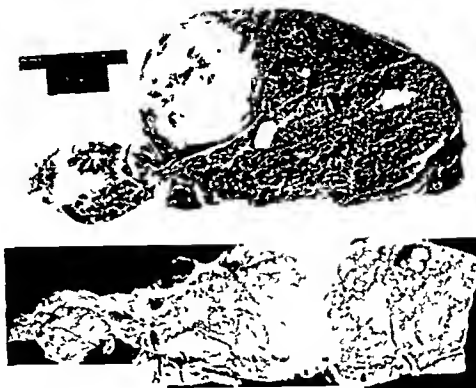


FIG. 2. Photographs of metastases in liver. Top: Note central necrosis and hemorrhage in large nodule. Bottom, left: Note scar of previous operation beneath tumor nodule. Bottom, right: Solid metastasis.

2.5 cm. in diameter. The sectioned surfaces appear homogeneous and yellow-ochre in color. Local extensions into the muscularis and often dimpling of the serosa may be observed. Microscopically, they are composed of columns or small nests of poly-



FIG. 3. Microphotograph of the tumor in the ileum. Note the normal crypts in the mucosa immediately adjacent to the tumor (hematoxylin and eosin— $\times 80$).

hedral cells, separated by a fibrous or muscular stroma. They show a remarkable uniformity in the size and staining reactions of both cell and nucleus. Mitotic figures are only rarely seen. In those that

believes that the stroma results from hypertrophy of previously existing muscle bundles stimulated to proliferation by the presence of the newly formed tumor cells. Noteworthy, is the almost total absence of areas of necrosis in the primary tumor, and when present these are extremely minute, occur in the center of the nests and give the impression of acinar formation. The metastases reproduce both the structure and staining reactions of the primary tumor. The vascularity varies from case to case but is usually quite abundant.

The case herewith reported demonstrates all these features and testifies to the presence of liver metastases for many years, death finally occurring from another condition.

CASE REPORT

B. K., a female, forty-four years of age, was admitted to The Jewish Hospital of Brooklyn on October 11, 1940, because of a cough of two days' duration, dyspnea, swelling of the abdomen and lower extremities, weakness, fatigue and a peculiar cyanosis of the upper half of the body of two years' duration. These symptoms were referred to a cardiac lesion from which she made exitus on November 3, 1940, and which Millman will report. Related to the present discussion, however, is her more

remote history. In 1935, she was twice admitted to another hospital with menopausal symptoms, itchiness of the skin in the absence

rounded borders. (Fig. 1.) This extended into the muscularis and produced a dimpling of the serosa. All the tumor nodules were firm or

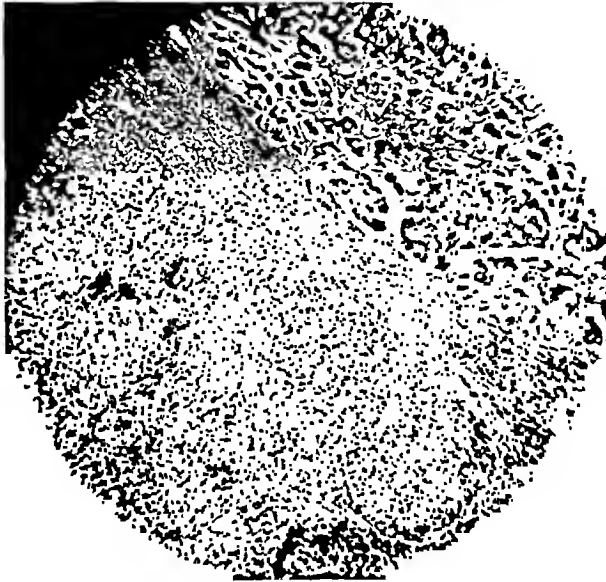


FIG. 4. Microphotograph of tumor metastasis in the liver. Note fatty changes in the liver cords adjacent to the tumor (hemotoxylin and eosin— $\times 90$).

of visible jaundice and general weakness. Physical examination revealed an enlarged liver and during her stay she had several bouts of fever. She refused operation on the first occasion but returned later for a laparotomy. At that time an encysted soft mass medial to the gallbladder was drained. The material obtained was soft, friable and structureless and was reported histologically as necrotic tissue. From the material obtained no more specific diagnosis could be made. A sinus tract developed and persisted until closed surgically two years later. No symptoms related to the abdomen developed in the subsequent years. Her bowel habits had always been regular and she had never noted her stool to be black or blood streaked. On her last admission the stool on two occasions was strongly positive for occult blood.

At autopsy the proximal ileum revealed six nodular masses contained within its wall. The largest measured 2 cm. and the smallest 0.2 cm. in diameter. Four were within the submucosa and projected into the lumen of the bowel with an intact mucosa covering them. One was pedunculated with pinpoint areas of ulceration in the overlying mucosa. The sixth nodule had a depressed center and firm

rubbery in consistency and of a homogeneous yellow-brown or ochre-color in the sectioned surfaces. The appendix was not remarkable. In the mesentery of the ileum there was a firm spherical nodular mass measuring 3.6 cm. in diameter. On section it was similar in appearance to the nodules found in ileum.

The liver weighed 1,600 Gm. and measured 20 by 21 by 10 cm. At the inferior margin of the center of the right lobe there was a scarified construction with numerous adhesions to the abdominal wall and transverse colon. The liver also contained numerous tumor masses which measured up to 2.5 cm. in diameter. (Fig. 2.) One of these was fluctuant and presented at the dome of the right lobe. On section it was well circumscribed with a peripheral zone of yellow-brown rubbery tissue and a central area that was dark red, mushy and friable. The remaining nodules were firmer and of an ochre-color on section.

Microscopically, the tumor lay within the submucosa of the ileum. (Fig. 3.) In some cases the mucosa was denuded, and in one instance the nodule extended into and replaced the muscularis. It was composed of polygonal cells with well defined cytoplasmic borders, faintly granular acidophilic cytoplasm and uniform

oval nuclei. These cells were closely approximated and arranged for the most part in solid nests. The central portions of some were

usual descriptions as does the absence of large areas of necrosis in the primary growth. The argentaffilic granules are



FIG. 5. Same as Figure 3 under higher magnification (hematoxylin and eosin— $\times 1200$).

absent, suggesting an acinar arrangement. (Fig. 5.) Other areas showed a papillary arrangement with stalks of loose fibrous connective tissue bearing distended capillaries. Separating the islands of tumor cells was a stroma consisting of hyalinized fibrous connective tissue and some muscle fibers. Some of the cells presented dark granules within the cytoplasm, when stained by the technic described by Masson. The metastases in the lymph node were uniformly composed of cells in nests, separated by a fibrous stroma. In the liver, the cords of liver cells immediately surrounding the tumor were flattened and broken down. (Fig. 4.) Nests of cells similar to those seen in the ileum comprised the nodules but in some the central portion showed extensive hemorrhage and necrosis with complete loss of tumor structure.

DISCUSSION

Many of the features commonly associated with argentaffin tumors are demonstrated in this case. The gross and microscopic appearance conforms with the

found only in a few of the tumor cells and is in keeping with Masson's contention that this is related to the functional state of the cells.

It is probable that the "liver abscess" drained four years before her death was in fact a metastatic nodule with central necrosis. This is borne out by the obstinate character of the postoperative draining sinus, and the presence of similar masses in the liver at autopsy. Despite this prolonged existence of metastases and of multiple primary lesions no remarkably clinical manifestation of the disease presented itself in the ensuing years. The patient died of a cardiac disease entirely unrelated to the condition described and their presence was unsuspected until found at necropsy.

SUMMARY

1. A case has been presented of multiple argentaffinomas in the ileum with metastases to the lymph nodes and liver.

2. The literature on the subject has been brought up to date.

REFERENCES

1. ARIEL, M. Argentaffin tumors of the small intestine. *Arch. Path.*, 27: 25, 1939.
2. BAILEY, O. T. Argentaffinomas (carcinoids); benign and malignant. *Arch. Path.*, 18: 843, 1934.
3. BUNTING, C. H. Multiple primary carcinomata of the ileum. *J. H. H. Bull.*, 15: 389, 1904.
4. CAMERON, A. L. Malignancy of jejunum and ileum. *Ann. Surg.*, 108: 203, 1938.
5. CARR, J. L. Argentaffin tumors of small bowel, with report of two which caused intestinal obstruction. *Am. J. Surg.*, 13: 56, 1931.
6. CHRISTOPHER, R. Iliac carcinoid: case report with obstruction resection and recovery. *Surg., Gynec. & Obst.*, 58: 903, 1934.
7. COOKE, H. H. Carcinoid tumors of the small intestine. *Ann. Surg.*, 107: 203, 1938.
8. FORBUS, W. W. D. Argentaffine tumors of the appendix and small intestine. *J. H. H. Bull.*, 37: 130, 1925.
9. GOSSET, A. et MASSON, P. Tumeurs endocrines de l'appendice. *Presse méd.*, 22: 337, 1914.
10. HUMPHREYS, E. M. Carcinoid tumors of the small intestine: a report of three cases with metastases. *Am. J. Cancer*, 22: 765, 1934.
11. JONES, C. B. Argentaffin cell tumors: carcinoids of small intestine and appendix. *Am. J. Surg.*, 34: 294, 1936.
12. KOCH, F. Malignant carcinoids. *Chirurg.*, 12: 270, 1940.
13. KROMPECHER, G. Über die Basalzellentumoren der Zylinderepithelseimhute mit basander Berücksichtigung der "Karzinoid" des Darnns. *Beitr. z. path. Anat. u. z. allg. Path.*, 65: 79, 1919.
14. KROSS, I. Carcinoid tumors of small intestine. *Am. J. Digest. Dis.*, 6: 725, 1939.
15. LATIMER, E. O. Malignant argentaffine tumors of the appendix. *Am. J. Surg.*, 54: 424, 1941.
16. LEE, W. E. and TAYLOR, T. S. Argentaffine tumors (carcinoids) of terminal ileum; cause of obstruction. *Surg., Gynec. & Obst.*, 59: 469, 1934.
17. LUBARSCH, O. Über den Primären Krebs des Ileum nebst Bemerkungen ueber das Gleichzeitige Vorkommen von Krebs und Tuberculose. *Virchow's Arch.*, 11: 280, 1888.
18. MALLORY, T. Multiple carcinoid of ileum. *New England J. Med.*, 222: 684, 1940.
19. MASSON, P. Les neurones sympathiques de l'appendice oblitérante. *Lyon Chir.*, 18: 281, 1921.
20. MASSON, P. Carcinoids (argentaffin cell tumors) and nerve hyperplasia of the appendicular mucosa. *Am. J. Path.*, 4: 181, 1928.
21. MASSON, P. The significance of the muscular "stroma" of argentaffin tumors (carcinoids). *Am. J. Path.*, 6: 449, 1930.
22. MCGLANNON, A. and MCCLEARY, S. Carcinoid tumors of the small intestine. *J. A. M. A.*, 89: 850, 1927.
23. MEEKER, L. H. A case of malignant carcinoid of the ileum. *Arch. Path.*, 14: 264, 1932.
24. MÖRL, F. Carcinoid of small intestine. *Beitr. z. klin. Chir.*, 153: 71, 1931.
25. OBENDORFER, S. Karzinoid Tumoren des Dünndarns. *Frankfurt. Ztschr. f. Path.*, 1: 426, 1907.
26. PRICE, I. Carcinoid tumor of Meckel's diverticulum; case. *Brit. J. Surg.*, 23: 30, 1935.
27. RAIFORD, T. S. Carcinoid tumors of the gastrointestinal tract. *Am. J. Cancer*, 18: 80, 1933.
28. RAONSON, W. B. Primary carcinoma of the ileum. *Lancet*, 2: 1021, 1890.
29. RITCHIE, G. Argentaffin tumors of the small intestine; report of four cases, one with metastases. *Arch. Path.*, 10: 853, 1930.
30. ST. GEORGE, A. V. Carcinoids of the appendix. *Am. J. Clin. Path.*, 4: 297, 1934.
31. WARFIELD, J. O. Argentaffinoma of ileum; case. *M. Ann. District of Columbia*, 8: 242, 1939.
32. WILLIS, R. A. Argentaffin carcinomata of small intestine. *M. J. Australia*, 2: 40, 1940.
33. WOOD, W. Q. Carcinoid tumor of lower ileum. *Brit. J. Surg.*, 23: 764, 1936.
34. WYATT, T. E. Argentaffine tumors of the gastrointestinal tract. *Ann. Surg.*, 107: 260, 1938.



AMPUTATION OF A BUTTOCK FOR ERADICATION OF A CAVERNOUS HEMANGIOMA*

JAMES B. WEAVER, M.D.

AND

MERVIN J. RUMOLD, M.D.

Associate Professor of Clinical Surgery, University of
Kansas School of Medicine

Associate in Surgery, University of Kansas School of
Medicine

KANSAS CITY, KANSAS

CAVERNOUS hemangiomas of skeletal muscle and other tissues of the lower extremity are not rare and the subject has been covered in several detailed reports.^{1,2,3} The following case is of interest because an amputation of a buttock was necessary for relief.

CASE REPORT

A twenty-nine year old woman entered the University of Kansas Hospitals January 14, 1939. In 1926, at the age of sixteen years, she first noticed a painless enlargement in the trochanteric region of the right thigh. This mass, which was said to be a lipoma, was excised five years later (1931) because of persistent gradual enlargement.

After two years (1933) there was recurrence of the tumor and a mass was also noted in the adjacent midgluteal region. These tumors slowly increased in size and in two years time (1935) became tender and painful. The pain was localized in the gluteal region in the beginning, but finally radiated down the posterior thigh, calf of the leg and into the heel. A second operation was performed in February, 1938. An incision was made through the old scar and the patient was informed that a "fatty and blood" tumor was removed.

This second operation afforded no relief from pain and, according to the patient, the mass in the buttock was still present. The pain progressed until the patient was bedridden most of the time.

One of the authors (M. J. R.) was then consulted and attempted a third operation, November 15, 1938. A longitudinal incision was made over the tumor mass in the buttock. A very extensive and invasive vascular tumor was found in the gluteal muscles which extended down to and encircled the sciatic nerve.

Due to profuse hemorrhage, excision was deemed impossible at that time. A section of the neoplasm was removed and the pathological diagnosis from the gross and microscopic picture was "diffuse cavernous hemangioma of skeletal muscle."

The right buttock was much larger than the left. There was a tender, doughy, tumor mass which had apparently invaded the entire buttock and had extended below the gluteal fold. The superficial veins were very much enlarged over the mass.

A radical operation was planned and, with several suitable blood donors at hand, was carried out on January 15, 1939. An incision was made from the posterior superior spine of the ilium along the border of the sacrum and coccyx across the gluteal fold and thence lateralward. A large skin flap was turned back to expose the gluteal region. The gluteus maximus and medius, gemelli, pyriformis and obturator internus muscles were found to be infiltrated with a vascular tumor. These muscles were freed from their mesial attachments, dissected lateralward and removed in their entirety. The mesial three-fourths of the gluteus minimus muscle and a considerable portion of subcutaneous fat were also removed. At the level of the gemelli muscles the tumor encircled the sciatic nerve and descended with it about three inches below the gluteal fold. The mass was dissected free from the nerve and was found not to infiltrate it at any point. The skin flap was then laid back and sutured in place.

There was considerable blood loss. Five hundred cc. of normal saline solution was given by the intravenous route and 1,200 cc. of whole blood as transfusion during the operation. The patient left the operating table with a systolic blood pressure of 60 mm. of mercury. She was given a transfusion of an additional 500 cc. of blood immediately upon her return to bed.

* From the University of Kansas Hospitals, Kansas City, Kansas.

The pathologist's diagnosis of the material removed at operation was "cavernous hemangioma of skeletal muscle."

cosmetic aspect improved by the wearing of a sponge rubber pad attached to her girdle which fits over the affected area. To date (No-

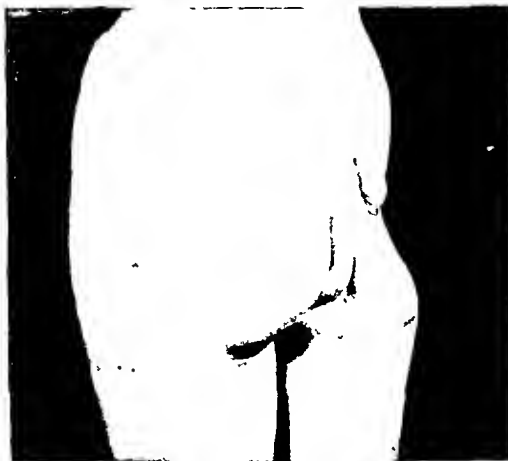


FIG. 1. Left semilateral view showing amputation of right buttock.



FIG. 2. Right semilateral view showing amputation of right buttock.

The immediate postoperative recovery was uneventful and the patient left the hospital on the seventh postoperative day. Thereafter a portion of the skin flap, about one inch wide and six inches long, sloughed along the longitudinal portion of the incision. This healed very slowly and was not materially improved by an attempt at secondary closure. Healing was complete at the end of eight months and relief from pain was complete.

The present appearance of the patient may be noted in Figures 1 and 2. The skin is adherent to the innominate bone and greater trochanter, but causes no discomfort except in sitting. This condition is relieved and the

venember, 1940) there is no evidence of recurrence.

The functional result is excellent. The patient walks with a barely perceptible limp and swims and plays tennis with no difficulty.

REFERENCES

1. DAVIS, J. S. and KITLOWSKI, E. A. Primary intramuscular hemangiomas of striated muscle. *Arch. Surg.*, 20: 39, 1930.
2. JENKINS, H. P. and DELANEY, P. A. Benign angiomatous tumors of skeletal muscles. *Surg., Gynec. & Obst.*, 55: 464, 1932.
3. WEAVER, J. B. Hemangiomata of the lower extremities. *J. Bone & Joint Surg.*, 20: 731, 1938.



New Instruments

AN INEXPENSIVE ELECTRIC DRILL, SAW AND KIRSCHNER WIRE DRILL GUIDE

W. COMPERE BASOM, M.D.

AND

LOUIS W. BRECK, M.D.

On Orthopedic Staff, El Paso City County Hospital

Diplomate of the American Board of Orthopedic Surgery

EL PASO, TEXAS

HOLES can be drilled much more easily with an electric drill than with a hand drill. Bone grafts can be easily and quickly removed with an electrically driven saw. In some operative procedures, a bone saw is superior to any other instrument. The electrically driven drill and saw have a definite place in the surgeon's armamentarium. There are many motor drill and saw sets on the market. Since all of them are expensive, we have devised the following:

ELECTRIC MOTOR HAND DRILL

There are numerous electric hand drills available for work other than surgical. These machines give good service and withstand considerable abuse. About five years ago we first attempted to use ordinary electric drills in our surgical work. The first motor functioned satisfactorily and withstood sterilization by baking very well. This motor was larger and more powerful than necessary. It also was a high speed type, consequently one of us (L. W. B.) began to use a small electric drill. (Fig. 1.) This drill turns at a low speed. It can be stopped during full speed by strong pressure of the fingers on the rotating chuck without danger. Even so it has sufficient power to operate any size bone drill or saw. It has a handle and can be held securely and in a balanced position for all types of work. This motor has functioned satisfactorily for four years in continuous use.

Three changes were necessary before this drill was first used in the operating room. First it was dismantled. The outer shell and metal fixtures including all parts of the chuck were plated with nickel. At the electric motor repair shop, the armature wiring was painted with insulating enamel and baked in order to provide adequate resistance to moisture. A three wire cable was substituted for the conventional two-wire cord so that the motor could be grounded during operations. The dangers resulting from a short circuit were thus avoided. The finished product has the appearance of a good surgical instrument and can withstand steam autoclaving.

DRILL POINTS

These were purchased from the local dime store. In our experience they do not break as easily as the high carbon variety. A complete set can be obtained at an amazingly low price.

SAW

Two blades were purchased from a surgical supply house. One blade had a diameter of one and one-half inches. The other had a diameter of three-fourths of an inch. The spindles were designed for the motor, and a machine shop manufactured them exactly as we desired.

KIRSCHNER WIRE DRILL GUIDE

A motor driven drill point operates much better than a drill point which is driven

manually. Therefore, an attempt was made to devise an attachment by which a Kirschner wire could be driven smoothly in place. The collapsible out rigger type

the Kirschner wire drill guide extends from two to three inches beyond the chuck of that instrument. This small length of wire does not "whip" during rotation.

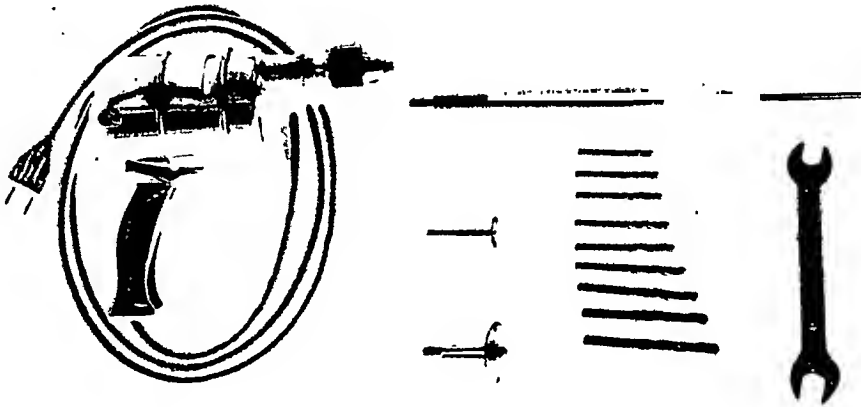


FIG. 1. Photograph of the electric drill with the large and small circular saw attachments, a set of drill points, a wrench to stabilize the motor shaft when the chuck is being tightened. At the upper right is pictured the Kirschner wire drill guide instrument with a Kirschner wire in place.

of guide for a Kirschner wire is at times cumbersome and difficult to operate in a small incision or near another wire. The following instrument was therefore designed:

This instrument was made from a rod of iron, which was seven inches long and three-eighths of an inch in diameter. A hole one-eighth inch in diameter was drilled throughout its entire length. From the dime store, a small chuck was purchased and all of its parts were plated with nickel. Threads to match this chuck were cut on one end of the iron rod. On the other end of the rod, the diameter was reduced to one-fourth inch for a distance of one-half inch so as to adapt the rod easily to the chuck of the electric drill. Thus when this instrument is fastened to the motor, there is formed a long hollow shaft into which the Kirschner wire can be placed. The small chuck on the end of the rod can be tightened and the wire is thus firmly held. The average wire, when fully sunk into

In fact we usually allow the point of the wire to project that distance beyond the chuck of the Kirschner wire drill guide when wire is first being drilled into the bone.

This Kirschner wire drill guide will also fit the average hand drill and can be operated manually if desired.

There are three imperfections to this instrument: First, the Kirschner wire must be gripped along its shaft by the chuck. This part of the Kirschner wire must necessarily be round. Thus, if the chuck is not tightened firmly, it will slide around the wire. If all parts of the chuck are kept smooth and lubricated, it will function satisfactorily. Second, after the wire is drilled in up to the chuck it is necessary to loosen the chuck, slip a short length of wire out of the instrument, and re-tighten the chuck if the wire must be drilled deeper than three inches. Third, the shaft of the motor has a slight degree of instability. During the operation of the drill point or

saw blades, this is not noticeable. However, the Kirschner wire drill guide extends the shaft for sufficient distance to cause the point of the wire to form a small circle during rotation. If the wire point is placed into the tissue to be drilled and then put in motion, this factor likewise is unimportant.

The small number of imperfections can be tolerated easily when one considers that the whole expense amounts to only \$26.25.

CONCLUSIONS

A satisfactory surgical instrument has been constructed from an ordinary electric hand drill.

An account was given of steps necessary to procure drill points and saw attachments.

A Kirschner wire drill guide was presented.

The cost of the complete set was only \$26.25.



ANKYLOSIS of a joint or stiffness of the adjacent soft parts is due not to immobilization but to pathologic changes. Such changes in turn are due to irritation, inflammation, tissue destruction, and scar formation.

The brief excerpts in this issue have been taken from "Wounds and Fractures," by H. Winnett Orr (Charles C. Thomas).

A POSITIVE SHOULDER LIFT FOR FRACTURED CLAVICLES

H. C. MASLAND, M.D.

Fracture Surgeon to Methodist Home for the Aged

PHILADELPHIA, PENNSYLVANIA

IN fractures of the clavicle the difficulty has been the inability to lift and hold the shoulder in the up, out and back

to engage in the appropriate holes in the axillary piece.

The elements of this instrument are a



FIG. 1. 1, strap hook; 2, universal angle splint; 3, lifting straps; note position under the connecting links and around the splint troughs.

position necessary to bring the bone ends into apposition. It is quite apparent that to accomplish this purpose the lifting power must rest upon an unyielding base.

The device illustrated possesses those factors that will permit practically an anatomical apposition of the bone ends. The fundamental feature is the placement of a metal ring fitted to the individual diagonally around the thorax cage of the affected side. This ring is composed of two semi-elliptical pieces. They can be shaped by hand to fit a thin or stout person. The axillary piece has holes uniformly spaced along its length. The shoulder piece has screw pins rivetted on its ends. These are

chest ring, a strap hook with two straps attached and a universal angle splint.

In assembling this instrument the axillary semi-elliptical ring is laid comfortably high in the axilla with the ends pointing to the opposite shoulder. The shoulder ring piece is placed in the angle of the neck with the ends overlapping the ends of the axillary piece. The particular holes on the axillary piece with which the screw pins on the shoulder piece mate are noted. The ring pieces are now removed and the posterior overlapped sections are connected. The screw pin is inserted in the mating hole and a nut holds it secure. The other end is bound with adhesive

plaster. The anterior overlap is not connected at this time as it is left open to spring the ring into position on the chest. The strap hook is inserted in that hole in the axillary piece which will give the correct directional lift to the shoulder.

Except for the anterior overlapping portion the ring is padded with a strip of felt held on with an artificial leather bandage. The anterior overlapping ends are opened to permit springing of the ring into position on the chest. The anterior overlap is now connected as was done posteriorly. The padding is then completed on this section. The ring is coated with petrolatum.

The universal angle splint is angulated and the connections screwed tight to hold the arm in the Velpeau position. It is padded and held to the arm and forearm with adhesive plaster bands.

The lifting straps from the hook are passed to the inside of the connecting links of the splint and around the medial sections of the arm and forearm splint troughs.

The shoulder is now raised to the correct position and so held with the lifting straps.

Should there be any uncorrected uplift of the clavicle, it can be brought into place

with a padded plate held down with adhesive bands attached to the ring front and back.

In a separation of the clavicle from the acromion process this instrument is of outstanding value. The plate laid over the clavicle and drawn with adhesive straps to the ring holds the clavicle against the upheld shoulder in permanent apposition with the acromion process.

The following are the specific features of this instrument: (1) The weight of the arm is held up with no drag and no discomfort. (2) Moderate movement of the shoulder joint is permissible during the treatment. (3) The instrument moves synchronously with respiration, thus maintaining the positional relations of the parts. (4) Body movements are not restricted. (5) There is no injurious trespass upon vessels or nerves. (6) With a properly placed lift of the shoulder, the bone ends come into practically anatomical apposition. (7) Particularly in acromioclavicular separations the two bones can be brought into and held in fine contact. (8) The instrument may be of service in fractures of the scapula.

Almost needless to say, for best results, fracture deformity reductions are emergency propositions.



Selected Book Reviews

TWO outstanding works that are "musts" for medical students and a majority of practitioners, are Alfred C. Beck's* "Obstetrical Practice" and Henry A. Christian's† "The Principles and Practice of Medicine."

The first edition of Beck's "Obstetrical Practice" was published in 1935 and was reprinted in 1936. It enjoyed an instantaneous success. We personally know of a medical student of one school who visited a student of another school. This student had Beck's book and the first student was so impressed he bought a copy. In two weeks' time half of his classmates owned copies. In 1939, the second edition came out. This was reprinted in 1941. In 1940, the first Portuguese edition was published. And now we have an enlarged and in many parts, a rewritten third edition.

For nearly thirty years Beck has had the reputation of being one of *the* great obstetrical teachers. There are many kinds of obstetricians; there is the man who is a "book and/or research" obstetrician. As a clinical worker usually he leaves much to be desired. We know of a late obstetrician, famous throughout the civilized world, who made you wince when he attempted to do a low forceps extraction. Then there is the man who has little scientific background or a thorough basic training, but who, nevertheless, has what we call "good hands." He is expert in doing a podalic version, converting an impacted face into a vertex or one of the various methods of cesarean section. Some can impart knowledge and some are mute on this score. Dr. Beck combines all three of these men. He can and does teach; he has the scientific background and knowledge, and he is a skillful operator. In addition, he wrote the book first hand and, ever keeping the student in mind, fashioned it to fit his needs.

* Obstetrical Practice. By Alfred C. Beck, M.D. Third Edition. Baltimore, 1942. Williams & Wilkins Company. Price \$7.00.

† The Principles and Practice of Medicine (Originally by Sir William Osler). By Henry A. Christian, M.D. Fourteenth Edition. New York, 1942. D. Appleton-Century Company. \$9.50.

In many instances previous chapters have been rewritten and brought up to date. The arrangement is logical and practical. The drawings are outstanding and are a great aid to the text, and these

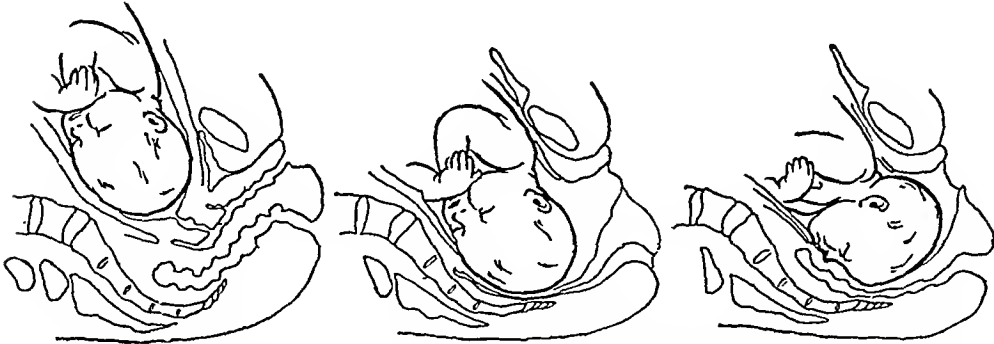


FIG. 1. Three figures from a series of twenty-four drawings which summarizes the L.O.A. mechanism. (Figures 202, 203 and 204 in Beck's "Obstetrical Practice." Williams & Wilkins Company.)

drawings are different, inasmuch as Dr. Beck has devised a new method for the use of color. There are seven chapters on operative obstetrics. We learn the proper way to prepare the parts for a cesarean operation under local anesthesia, various technics of cesarean section are given in detail, as are the Porro operation and the Waters procedure. This book now has grown to 938 pages; there are a 1,064 illustrations, a bibliography at the conclusion of each chapter, and an ample index.

The publishers are to be commended for offering this textbook at a remarkably low price. Many outstanding men who know values and know what they are talking about declare Beck's "Obstetrical Practice" the best work of its kind to date in the English language.

Fifty years ago William Osler wrote his "Principles and Practice of Medicine." Naturally such an outstanding work would continue after its creator had passed on. First, Thomas McCrae was the editor who carried on from edition to edition, and then Henry A. Christian occupied the chair. Both worked with Osler in their early days; both have been leaders of medicine in their own right; each of them incorporated his own knowledge and personality and kept the work alive and up-to-date. This edition, celebrating its semi-centennial (1892-1942), is no longer truly Osler's or McCrae's or Christian's volume, but an accepted standard work by Osler, McCrae and Christian.

“The text remains in a large measure the portraiture of disease as it has been observed by three authors against a background of publications embodying the periodic advances in medical knowledge made by medical men the world over.”

This edition was published to bring up to the minute the many new methods, agents and important new material that goes hand in hand with medical progress.

This the fourteenth edition (1,475 pages, a working bibliography at the end of each chapter, and a more than adequate index) goes into the later methods of treatment, especially chemotherapy, increased emphasis is placed on the functional aspects of medicine, the subjects are rearranged into more logical sequence, epidemiology is stressed, necessary pediatric considerations are included, and newly identified diseases are discussed.

Dr. Christian has done a marvellous book. After all, this work needs neither introduction nor a review in the ordinary sense of the word. It is a recognized medical classic and Dr. Christian in keeping it one of the great medical classics has made for himself a name that will go down the years when all who now walk upon this earth will have departed.

The American Journal of Surgery

Copyright, 1943 by The American Journal of Surgery, Inc.

A PRACTICAL JOURNAL BUILT ON MERIT

Fifty-second Year of Continuous Publication

NEW SERIES VOL. LX

MAY, 1943

NUMBER TWO

Editorials

EMERGENCY X-RAY EXAMINATIONS IN SUSPECTED SKULL FRACTURES AND BRAIN INJURIES

IN many hospitals it is almost routine practice to hurry cases of head injury to the x-ray department to rule out fracture. That such injuries are very frequent is shown by the statistics of the Mocks* who have estimated that 600,000 head injuries, one-third of them proved skull fractures, occur annually and that with an average mortality rate of 10 per cent for serious head injuries without fracture and an average death rate of 30 per cent for proved skull fractures, nearly 300 persons die each day in the United States from brain injury.

This note is intended to encourage greater conservatism in the employment of the immediate x-ray examination of severe skull injuries on their arrival at the hospital for emergency treatment. We see numerous instances of skull injury with the patients in shock and completely unable to cooperate with the radiologist in the x-ray examination. Some patients are unconscious, some are greatly excited; most of them do not fully comprehend the necessary instructions given during the course of the x-ray manipulations.

As pointed out by the Mocks the most dangerous period of cerebral shock occurs during the first six hours; it causes many of

the earlier deaths. Every patient with a head injury should be treated during the first hour or two after admission as a case of potential shock unless menacing hemorrhage threatens his life. This is no time for x-ray study.

It should be a rule, of course, as Mock has emphasized, that an x-ray examination should be made in every head injury "but never in the presence of cerebral shock." The writer has been impressed that there seems to be undue haste in rushing emergency skull cases to the x-ray department. This seems to have been true in the group of Mock's collection of cases which did not do well. If there are associated injuries, e.g., in the extremities, the temptation for early x-ray procedure seems to be still greater; and with such patients it has been the case that not only the suspected extremity but the skull have been submitted to x-ray study.

The writer urges that in suspected skull fractures in severely injured patients it be the general rule to delay the x-ray examination, perhaps for days. With the possible exception of those cases in which the suspected fracture seems to be located over the middle meningeal artery the immediate treatment of the case is not going to be changed by the x-ray findings. Even in these instances of suspected hemorrhage a bedside x-ray examination can be done.

* Mock and Mock. Management of skull fracture injuries and brain injuries. *J. A. M. A.*, 120: 498-505, 1942.

When the patient has been brought into good condition, the x-ray procedure should be ordered. In this stage the patient can be moved to the x-ray department, unless his associated injuries prevent it. Even in the latter event a bedside study with the aid of grids will produce films satisfactory in the diagnosis of most fractures.

Of course, at some time before he leaves the hospital every case of head injury should have a thorough examination with the x-ray. As Max Peet has stated, "this examination is made largely as a matter of record and in preparation for possible medicolegal complication."

One sometimes hears the remark that there are many skull fractures which cannot be demonstrated by the x-ray. This is a

statement which is probably true of many hurried x-ray studies, but it need not be so. When the patient is in proper condition, a thorough examination should be carried out, which means that to the ordinary films should be added a submental-vertex film and films, preferably stereoscopic, in the Towne's position. A thorough x-ray investigation of the skull for fracture should always include postero-anterior, antero-posterior (Towne's position), submental-vertex, and right and left lateral films. These will constitute a complete survey of the cranium, including its base. Stereoscopic films are always helpful. It is very unlikely that a skull fracture should escape such a complete investigation.

JAMES T. CASE, M.D.

AN HISTORICAL EVENT AND A GREAT PHYSICIAN

OUR great, great-grandchildren, and their great, great-grandchildren will refer to December 7, 1941, as "Pearl Harbor." On that day the Japanese attacked our country without a declaration of war and without warning. Pearl Harbor will go down in history alongside of Valley Forge, Bunker Hill, Yorktown and Gettysburg. At Pearl Harbor, on that memorable day, was a great physician and executive, a man of whom the Navy should be and, no doubt, is proud—Captain Reynolds Hayden.

Captain Hayden was in charge of the hospital at Pearl Harbor, and in the following pages he gives us a graphic account of that terrible day and the following two or three days. The first seventy-two hours must have been hell. Captain

Hayden has written an absorbing and interesting ~~report~~ of that raid and the part the hospital doctors and personnel played when large numbers of severely wounded were rushed to the hospital already filled to capacity. The article is told with restraint; even the scientific part is done modestly; nowhere is there a suggestion of rodomontade. When we received this manuscript we read every word with increasing interest. We wished it were longer; and we know you, too, will find every word absorbing, and that when you finish reading it you will feel and know that Captain Hayden and his co-workers, physicians, nurses and volunteers, did an epoch making, marvelously efficient job.

T. S. W.

A SUGGESTION

THIS is not original. Would it not be well for our government to give some kind of button or emblem when a young man at his induction physical examination is not accepted in the armed forces because of physical disability? This goes for young physicians, too. At times it is embarrassing and mentally painful

for a young man, apparently healthy externally, to be stared at by people who wonder "why you are not in a uniform . . . a young man like you?" The young man cannot cry out, "I have two perforated ear drums," or "I have nephritis," or "both my legs below the knees are off." How about it?

T. S. W.

Original Articles

ACTIVITIES OF THE NAVAL HOSPITAL AT PEARL HARBOR FOLLOWING THE JAPANESE AIR RAID OF DECEMBER 7, 1941

COMMENTS ON THE CARE OF BATTLE CASUALTIES

CAPTAIN REYNOLDS HAYDEN, M.C.

United States Navy, Medical Officer in Command, Naval Hospital, Pearl Harbor

Now

District Medical Officer, Third Naval District

NEW YORK, NEW YORK

MORE than a year has passed since the surprise Japanese air raid on Pearl Harbor, an attack which was typically Japanese in thought and execution, which finally pushed us into the second World War and which was to have a markedly serious effect upon the allied war effort in the Pacific Ocean and Asia.

While a great deal has been published about the raid, the naval hospital there went through an experience which was a very concrete example of what may occur at any hospital in an area subject to air raids, an experience which largely revolutionized and stabilized the treatment of war wounds and burns. While the tremendous pressure of work in caring for casualties under air raid conditions can only be experienced, not described, it is believed that a description of the activities at the Naval Hospital, Pearl Harbor, on that fateful December 7th will be of interest to all and possible assistance to some in handling a similar situation elsewhere.

It must be emphasized that war surgery is not civil surgery. It is necessary to get away from the leisurely surgery of civil life. The treatment of battle casualties means the treatment of mass casualties because occasional casualties are routine at any hospital. In battle and especially in the

presence of an air raid, a great number of casualties are received in a short space of time, so that the number of patients requiring prompt treatment is out of all proportion to the number of doctors immediately available. All that is possible at first is what might be called advanced first aid: morphine, control of hemorrhage, prevention of infection and treatment of shock.

Speaking medically, the air raid on Pearl Harbor had three very unusual features. These were, first, the great number of casualties received at hospital in a short period of time; second, the fact that many patients had been overboard and were covered with fuel oil; third, the very high percentage of burn cases.

As you know, the enemy air raid on Pearl Harbor was a great surprise to us all. It occurred shortly before eight o'clock on a beautiful, quiet, peaceful Sunday morning such as is seen in any small town in the United States. I was in my quarters on the naval hospital reservation when I heard the roar of planes passing overhead. This was immediately followed by a loud explosion. I did not pay much attention to it because the naval hospital was located alongside the Army Hickam Air Field and across the channel from the Naval Air Station on Ford Island. We had planes

flying about us a great part of the time. Dynamite was being used in connection with construction work in the rear of the hospital. The explosion of 300 to 500 pounds of dynamite sounds quite similar to that of an air bomb. Then I heard more planes and more explosions. That was not quite normal and I started for the window to see what was going on. Just then my young son Billy, fourteen years old, dashed in the room and shouted, "They're Jap planes!" I asked, "Jap planes?" He said, "Yes, look at them" and pointed out the window. I looked out the window and three of them went by the second floor of my quarters and about seventy-five feet away. They were so close that the features of the aviators could be easily distinguished. The planes approached from the sea, flying low and hiding behind the hospital buildings so that they would not readily be seen. They did not attack the hospital but hedgehopped over it en route to military objectives.

I told my family to stay in the house and immediately went to the hospital where the officer-of-the-day was already getting all hands to their stations, distributing additional supplies to operating and dressing rooms, scattering ambulances and fire fighting apparatus about the hospital grounds so that they would not all be destroyed at once, etc. A considerable number of our ambulant patients were rapidly transferred from the wards to hospital tents in the rear of the hospital so that their beds would be immediately available for casualties. Quite a number of patients who were practically well or awaiting return of their ships to Pearl Harbor so they could be returned to duty urgently requested immediate discharge to duty so that they could join some unit and fight.

About ten minutes after the raid commenced, a Jap plane ablaze was seen coming down on a glide toward the center of the hospital. It looked as though it was going to make a direct hit on the middle of the main hospital building but very fortunately veered off a bit, carried away a

corner of the roof of the laboratory and about half of our animal house and crashed on the tennis courts alongside the hospital. It brought up alongside a frame house which immediately caught fire. Both fires were promptly extinguished by the hospital force. The Japanese aviator had been shot in the head and killed before the plane crashed so that it evidently came down entirely out of control. We considered ourselves very lucky.

A disturbing factor throughout the day of the raid was the reports over short wave radio sets that the water had been poisoned, that many Jap transports conveyed by war ships were landing troops here and there on the coast, etc. It was at first stated that our Army and Marines were keeping off these landing parties. About the middle of the day, it was reported in detail that large numbers of Japanese troops had landed on the north coast and were pushing back our troops. We were too busy to worry about such reports but, though I actually knew nothing about it, I tried to keep them from our people and said they were incorrect. The poisoned water rumor was most persistent and quite alarming to many but was finally disproved by water analyses. These reports were spread by short wave radio sending apparatus manned by Japanese fifth columnists in scattered houses, stores and cane fields. They were gradually located during the day and all the Japs handling them were shot.

About an hour after the raid started, we moved the hospital families living on the reservation from their quarters into the basement of the hospital where they were pretty well protected by reinforced concrete. They slept there until they were evacuated to the mainland on Christmas Day. I have frequently complimented these women and children upon the way they took all this. They were naturally frightened but were quiet and absolutely no worry to the rest of us—except for their presence. Under the circumstances, we would have preferred them to be in San

Francisco. It was, of course, impossible for us to have any real Christmas celebration but on Christmas Eve, our Red Cross Field Director got a small tree and trimmed it with some tinsel and ornaments. One of the doctors dressed himself up as Santa Claus and handed out some little present to each member of the families. While the occasion lacked the joyous frivolity to which we had all been accustomed for Christmas, the occasion was really very impressive and enjoyable. It made them all feel much happier and temporarily forget the next day when they were all to be evacuated and knew that they would have to run the gauntlet of Jap submarines between Honolulu and San Francisco.

We received our first casualty shortly after the raid commenced. It was a man who had been walking with his wife and baby down the road alongside the hospital. A shell fragment had carried away his left arm and part of the shoulder. He died soon after admission to the hospital.

About a half-hour after the raid commenced, we really began to receive casualties. We received them at an average of three a minute for the next three hours. They were brought to the hospital in all types of vehicles: ambulances, military and civilian trucks, private cars and delivery wagons. They were brought in by all manner of civilians. It was most inspiring to see the way they co-operated in bringing casualties to the hospital under fire. They evidently had no thought of possible injury to themselves or to their cars.

The immediate handling of such a flood of patients was quite a problem but successfully solved by distributing them to all wards and the main operating suite as they arrived. A receiving ward would have created a hopeless bottleneck. This distribution of patients was directed by the Commanding Officer and the Executive Officer. All other doctors on the hospital staff were working in the various wards with four operating teams in the operating suite.

The badly wounded, those demanding immediate surgical attention, were sent directly to the operating amphitheatre as rapidly as possible. While an effort was made to allocate other patients to wards in accordance with their types of injuries, each ward actually received many varieties of casualties. As a result, it was necessary to re-group the patients during the next two days by transfers from one ward to another in order to group similar classes of casualties together in the same ward or wards. Approximately 47 per cent of all casualties admitted were cases of burns. With the exception of some patients suffering from excessive inhalation of smoke, blast effect of high explosives, etc., the remainder were acute surgical emergencies.

Upon admission, all patients not known to have been previously morphinized, were given $\frac{1}{2}$ gr. morphine sulphate hypodermically followed by tetanus antitoxin, 1500 units, alone or combined with anti-gas serum. All service personnel have now been given tetanus toxoid and are immunized against tetanus. At the outbreak of war, however, many had not yet received the toxoid. Tetanus antitoxin was therefore administered. With casualties arriving so rapidly, it was necessary to assign a group of doctors and nurses to the morphinization of patients. The usual technic of administering hypodermic medication was of course totally inadequate for this occasion. A solution of morphine sulphate gr. $\frac{1}{2}$ to 1 cc. and a tray of sterile hypos in alcohol were therefore prepared. This enabled the administration of morphine to keep up with the flow of patients. All patients given morphine at the hospital that first day had a red M marked on their foreheads with mercurochrome in order to prevent their getting another dose for at least several hours. Preliminary cleansing of patients was impossible. While many were covered with fuel oil from head to foot, comparatively scant cleansing was all that could be done in this respect at the first treatment.

For the first three days after the raid, it was necessary for the entire hospital staff

to work twenty-four hours a day, snatching what sleep they could. For the next ten days, doctors, nurses and hospital corpsmen were divided into watches in order that the necessary work might be continued night and day. The operating suite had been previously blacked out and four operating teams worked in relays of two teams each for several days.

SHOCK

Upon admission, practically all patients were suffering from shock in varying degrees. Most deaths in the hospital occurred within twenty-four hours of admission and were due to either acute or delayed shock. The great importance of the prompt treatment of shock in the handling of battle casualties were impressed upon us all. It takes precedence over all other treatment except control of hemorrhage. Hemorrhage and shock account for most of the deaths on the battlefield. Some patients are hysterical and others depressed; all exhibit great anxiety; practically all are in pain. Both for pain and as first treatment for shock, these patients need $\frac{1}{2}$ gr. of morphine promptly. Following this and the routine of heat locally, came the intravenous administration of blood plasma, saline and glucose, or normal saline solutions.

It is extremely important that shock be controlled in severely wounded patients before any other treatment is instituted except immediately necessary first aid. If hemorrhage and shock cannot be adequately controlled, it is a waste of time to send a patient to the operating room. With both the Army and Navy at Pearl Harbor, some casualties received in the operating suite had to be returned to their ward for more shock treatment before they could be operated upon. With extensive burns, however, a first spraying or other local application may be done simultaneously with early shock treatment.

ACUTE SURGICAL CASES

A great variety of surgical cases were admitted: gunshot and shell wounds, large

and small, of all parts of the body; extensive wounds produced by bomb or shell fragments; traumatic amputations; wounds containing many metal fragments; simple, comminuted and compound fractures, large and small, some into joints and some with considerable loss of bone.

Upon admission to the hospital, these patients were immediately taken to a dressing room where a preliminary treatment was given. The wound was grossly cleansed, readily accessible metal fragments and badly torn skin and muscle removed, hemorrhage controlled, sulfanilamide powder poured or shaken generously into the wound and an occlusive dressing of sterile plain or vaseline gauze applied. We found the simplest method for handling the sulfanilamide powder was to shake it in from a salt shaker. No wound closure was attempted at this time. Fractures were reduced so far as practicable at a first dressing and a retention apparatus applied. The patient was then put to bed awaiting surgery and given shock treatment if necessary.

Following this preliminary treatment, patients were operated upon when time permitted and in accordance with the urgency of the case. Patients having fractures were x-rayed for further diagnosis when time permitted, usually on the second or third day.

At operation, wounds were thoroughly cleansed and then thoroughly débrided until there was normal appearance of tissue, bleeding and, in case of muscle, contraction. The entire wound was then again thoroughly frosted or dusted with sulfanilamide powder.

Sulfathiazole powder was used occasionally but was unsatisfactory. It formed a plastic cast which caused wound secretions to be retained and local infection did not seem to be as well combatted.

Wounds of the extremities were not closed unless very superficial or more than three days had elapsed since injury. These wounds should not be closed at the time of the first dressing. With both Army and

Navy, practically all wound infections occurred in patients who had received primary suture at the first aid station. The efficacy of this procedure is attested by the fact that less than 1 per cent of infections occurred in the large number of wounded treated by the Army and Navy after Pearl Harbor. Approximately the same results have recently been reported from the Solomon Islands area.

More than half of our fractures were compound. These were treated as I have outlined for other large wounds, the fracture reduced and a plaster cast applied, skeletal traction being incorporated in the cast as necessary.

The Orr-Trueta plaster cast technic was used by us for all cases of fracture and all patients having massive or extensive wounds of the extremities without fracture. Severe wounds of the soft parts demand splinting just the same as fractures do.

In fractures of the bones of the upper extremity, traction is usually not necessary. In war surgery especially, plaster of Paris is preferable but this is not always available in the field and these fractures may also be immobilized for transportation by the use of wire ladder splints, boards, folded newspapers, etc. Fracture of long bones of the lower extremity, however, will usually require traction. If plaster is not available, the Thomas splint is usually used. These splints frequently have to be applied under extremely difficult circumstances. Our hospital corpsmen at sea and in the field are trained to apply one to a leg properly in two minutes blindfolded.

Special attention is invited to the fact that our experience at Pearl Harbor definitely showed that sulfonamide therapy, both local and general, has revolutionized the treatment of wounds. Much has been written on this subject but our experience, gained through necessity, completely demonstrated that the free local use of sulfanilamide powder in wounds permits us safely to select the best time to operate upon these patients, with late débridement and other necessary surgery. Its use has

forever removed the bugbear of military surgeons, infection occurring in wounds not properly operated and débrided within the so-called "golden period" of six hours after injury. Cases too numerous to mention proved this point. Massive, lacerated and torn wounds, sometimes complicated by severe compound fractures, and which had received only the barest essentials of preliminary surgery plus sulfanilamide powder freely in the wound, were operated upon the second and third day after injury with excellent results. Of the many cases so treated, only one patient had a temperature over 99°F. during his stay in the hospital. At operation, these wounds were all found to be essentially clean and healthy. Infection was only found in those patients who had been given primary suture before arrival at the hospital.

Our naval medical records show that the use of sulfonamides and blood plasma has reduced the death rate for American troops wounded in the Solomon Islands to less than 1 per cent as against a rate of 7 per cent in World War I of all American soldiers wounded in the field.

Only one case will be mentioned in detail. This man had extensive, lacerated wounds of the lower third of each thigh involving the hamstring muscles. At first dressing, these wounds were grossly cleansed, generously filled with sulfanilamide powder and an occlusive dressing applied. By chance, he was not sent to the operating room for about seventy-two hours. At operation, the wounds were found to be clean and showed no evidence of infection. They were thoroughly débrided, severed muscles were sutured, more sulfanilamide applied and the wounds closed. Healing was by first intention.

All severely wounded patients also received sulfanilamide by mouth in routine dosage for several days to a week after injury. In severe cases, this was a necessary adjunct to local use of the drug.

Follow-up reports on these cases some seven weeks later, after they had arrived on our West Coast, stated that practically

all these wounds were clean, uninfected and rapidly healing. In the few instances in which suppuration was present, and this was never extensive, it was associated with the presence of a foreign body. With removal of these and adequate treatment, healing progressed rapidly. In numerous instances, the wounds had healed or secondary plastic closure had been obtained within seven weeks after the patients had been wounded. Following Pearl Harbor, some doubt was expressed that the positions of the bones in compound fractures treated by the sulfanilamide-Orr-Trueta method would be good. But on the West Coast, it was found that in fractures below the knee, with the exception of occasional moderate angulation which it was not necessary to correct, the fragments were in excellent position for a good functional result. There was no x-ray evidence of osteomyelitis. In the fractures of the femur, the plaster method was not so satisfactory in maintaining position but there was no infection.

We had one patient who suffered a compound fracture of the thigh with about a four inch loss of continuity in the upper half of the femur. He was given routine treatment so far as the wound was concerned and the leg put up in a plaster cast with traction so that the limb was of approximately the same length as before injury. It was hoped that sufficient periosteum remained to produce regeneration of bone. This patient was evacuated to a hospital on the West Coast. I was told last Spring that he was making good recovery but that there had been inadequate regeneration of bone and non-union. He will recover, however, with perhaps a three inch shortening of the leg. This is a much better result than the high amputation which would have been necessary if this line of treatment had not been followed.

A certain number of cases are received in which emergency amputations are necessary. In selected cases in which the patient is in good condition and adequate operative facilities are available, amputa-

tion with flap and primary suture is probably justified. The vast majority of such battle casualties, however, are received under adverse circumstances. In them, a guillotine type of amputation is usually advisable, all structures being cut across at the same level and the wound treated as any large open wound. Later, attempt must be made to cover the bone end with soft parts or re-amputation done if necessary.

Most of our anesthesia was by drop ether. This lends itself well to this type of surgery and in addition, when necessity demands, it may be given by those with little training.

At Pearl Harbor, we had a small amount of the then new sulfallantoin ointment for trial. We found that its use appeared to hasten the "cleaning up" of open wounds. Wounds that ordinarily required a week or more to present healthy granulating surfaces showed a healthy red color in two or three days and were ready for further treatment. A through-and-through wound of the thigh cleaned up very nicely under this treatment but markedly retrograded when the ointment gave out and other treatment was used. The cases in which sulfallantoin ointment was used included both bullet wounds and extensive shell wounds.

SPECIAL REGIONAL SURGERY

While on the subject of surgery, I want to emphasize briefly a few points about war surgery of the head, chest and abdomen.

Head. The majority of penetrating wounds of the head, although not immediately fatal, will result in death unless the wounds are properly treated from the beginning. Improvement of the technic of brain surgery by Dr. Harvey Cushing during the first World War reduced the mortality of these wounds from 60 to 20 per cent. The use of sulfanilamide has now produced a further decrease.

The wounds are usually compound depressed fractures. The scalp wound is often quite small and easily missed on examination but beneath these the x-ray will show

an extensive fracture and a missile in the brain. The hole in the outer table of the skull is usually small and that in the inner table many times larger. Bone fragments are carried into the brain, act as missiles, and cause much more damage than suspected.

Success in treatment of these wounds depends upon: (1) preliminary treatment at time of injury, (2) time of operation and (3) nature of operation.

All wounds of the scalp should be considered as serious. Even without associated skull fracture, these wounds are dangerous because of possible infection. Our ideas concerning wound infection have changed with the war. It is now known that many of the more virulent organisms do not enter the wound with the missile but are introduced when it is being dressed. The chief danger to the patient is from the mouths, throats or fingers of those who first inspect and treat the open wound.

Final suture and closing of scalp wounds, even without associated skull injury, should be done only in a properly equipped operating room where the wound can be properly and completely cleaned, débrided and sutured as any other wound, and skull fracture or brain injury properly treated if present. At the time of the first emergency dressing, all hair should be cut from the head or at least from about the wound itself. The wound edges should be cleaned with soap and water if available and the wound filled with sulfanilamide. A large, tight, sterile dressing is then applied. This will usually control hemorrhage. Morphine is contraindicated unless there are extensive painful wounds elsewhere. It should never be used routinely.

If circumstances are such that the patient cannot be transported within a reasonable time to a place where complete operating facilities are available, as thorough a surface operation as possible may be performed in the field dressing station. While this leads to primary healing of the scalp wound without treatment of the possibly co-existing skull fracture or brain

injury, these can be safely treated later if the scalp wound has healed and there is less danger of infection than if the scalp wound is left open indefinitely.

Upon arrival at the hospital, the usual examinations are made to determine extent of injury. In taking x-rays, a dark film must be obtained as bone fragments and perhaps the foreign body itself may be missed with an underexposed x-ray.

Operation should be done as soon as practicable, preferably not later than six hours after injury. If the wound is given the preliminary treatment previously described, however, the operation may be delayed as much as forty-eight hours and the wound still be treated as a fresh wound and closed without drainage. After that time, it is treated as an infected wound and left open.

The most important part of the operation is a thorough cleansing and débridement of the wound tract in the brain. This may contain hair, dirt, grass and fragments of bone. Damaged brain tissue and blood clots are removed by suction and all foreign material carefully picked or gently washed out of the wound. The tract is then gently irrigated with large quantities of sterile saline solution, all bleeding controlled, the wound tract filled with sulfanilamide powder and the wound closed. Sulfanilamide is nonirritating to the brain and as effective in wounds there as elsewhere.

The missile should be removed if reasonably accessible but, if small and deeply buried, it should be left alone.

The wound in the dura must be closed. If it cannot be drawn together, it should be patched by a piece of periosteum or fascia lata.

Postoperatively, sulfonamides are given routinely. Pain may be controlled by aspirin. Barbitol or other anticonvulsant drug should be given in small doses and continued for about a year.

In patients operated upon more than forty-eight hours after being injured, the wound tract should be cleaned and dé-

brided as just described, the entire wound filled with sulfanilamide up to the skin and the wound tract loosely packed with vaseline gauze or sterile gauze strips surrounded by rubber tissue.

Face wounds, while revolting, require no special treatment except in connection with the tongue. If the lower jaw and anterior attachments of the tongue are shot away, it tends to fall back into the throat and choke the patient. The tongue must be held forward. This is readily accomplished by placing a safety pin or suture through the midline of the tongue and pulling it forward. This also aids in controlling hemorrhage from about the base of the tongue. These patients should be evacuated face downward.

Chest. These wounds permit air to rush in and out of the pleural cavity, cause marked shock and death, and must be promptly closed if the patient is to live. They may be closed with a pad of gauze from the first aid packet, though moist gauze is better. If available, a large square of rubber tissue is preferable as it permits air, blood and exudates to flow out of the chest but prevents air from entering. If none of these are available, the wound must be quickly closed with anything available, the man's shirt, an ordinary thread and needle, etc.

Hemorrhage from the lung usually ceases spontaneously. Arterial hemorrhage, however, has to be controlled by ligation. Death usually results promptly if the large vessels of the chest are damaged.

As soon as the patient reaches a place where surgery is available, the wound should be rapidly cleaned and débrided, easily accessible foreign bodies removed and blood sucked from the pleural cavity if possible. Sulfanilamide powder should then be freely scattered in the pleural cavity and the wound sutured tightly. Empyema or lung abscess may develop later. Some of our patients developed fluid in the pleural cavity but no empyema.

Abdomen. Patients having abdominal wounds require early operation or they will

develop a fatal peritonitis and must, therefore, be evacuated before all other patients. Too much time should not be wasted trying to overcome shock before evacuation.

Upon arrival at the hospital, if there is doubt of intra-abdominal injury, it is better to do an exploratory laparotomy than to wait until the diagnosis is certain. Use open drop anesthesia unless an expert anesthetist is available. This type of patient does not do well under spinal or intravenous anesthesia.

When operating, excise the wound of entrance, pack with sulfanilamide and enter the abdomen through a separate incision. Remove intraperitoneal fluid by suction or sponging. Examine the entire abdominal cavity rapidly and systematically. Never conclude that the abdominal injury is slight because the wound is small and examine the abdominal viscera thoroughly regardless of location of the external wound. Control bleeding and close multiple bowel perforations transversely to protect the intestinal lumen. Resection should not be done unless the intestinal blood supply is inadequate. Scatter 8 to 10 Gm. of sulfanilamide through the peritoneal cavity and close the wound without drainage. Drainage is rarely indicated and may do more harm than good. None of ours were drained. Sulfonamides are given routinely by mouth for a week or ten days after operation.

A conscientious effort must be made to repair these wounds as recovery often occurs in an apparently hopeless case.

Patients with gunshot wounds of the abdomen, treated as above outlined by the Navy after the raid at Pearl Harbor, showed less than 1 per cent mortality though many patients were not operated upon for some five or six hours after injury. We had one patient who was not operated upon for about eight hours after being wounded and made a good recovery. These patients were all ambulant cases when they arrived on the West Coast eighteen days later.

During the first World War, there was a mortality of from 60 to 80 per cent among patients with gunshot wounds of the abdomen. Recent reports from the Solomon Islands' area, where the treatment above outlined has been used, show a mortality of less than 5 per cent among these cases.

Burns. Approximately 254 cases of burns were admitted to the Naval Hospital, Pearl Harbor. Practically all were flash burns from exploding bombs or torpedoes and preponderantly second degree burns. Some were oil burns.

So-called "flash burns" are burns caused by the very temporary but terrific heat produced by the flash of flame accompanying or immediately following the explosion of aerial bombs and torpedoes. A quite noticeable and very unusual feature of these burns was that those parts of the body surface which were covered by clothing of any kind were not burned. When the attack occurred, many men on board ship were below decks and in various stages of undress. They dashed to their stations without waiting to dress. Some had on trousers and no shirt; some were in their underclothes; some only had on a pair of trunks. Those wearing undershirt and trousers were burned only on the arms and face; those with trousers but no shirts were burned over the entire body above the waist; those wearing only trunks were burned over the entire body except about the hips; those fully clothed were burned only about the hands and face.

There were many first degree and some combined second and third degree burns but no pure third degree types. Burned areas covered as much as about 80 per cent of the body surface. The vast majority of cases were contaminated with fuel oil. Quite a number of patients had been overboard in water heavily coated with fuel oil and were covered with it from head to foot. All were given local treatment, some type of tanning process, as rapidly as possible. The following applications were used: tannic acid spray 5 to 10 per cent; 2 per cent aqueous gentian violet spray; triple

dye spray; 10 per cent tannic acid spray followed by silver nitrate 10 per cent; tannic acid jelly; sulfanilamide in mineral oil 0.8 Gm. to 100 cc. Bland ointments were used on hands and face.

Morphine sulphate gr. $\frac{1}{2}$ was administered hypodermically and repeated if necessary. Shock treatment consisting of heat, intravenous plasma, normal saline, or normal saline and 5 per cent glucose was started as rapidly as possible. Teams were organized to give each form of treatment. For the first forty-eight to seventy-two hours, only small amounts of dry plasma were available. Fairly large quantities of normal saline or saline and glucose solutions were given until more plasma became available. These were then supplanted by plasma or used in combination with it.

Because of the great number of burn cases, it was necessary to use anything that was available which would spray the solution. Ordinary flit guns were emptied, refilled with the medicated spray, and used to spray patients.

A large majority of the patients were covered with fuel oil but no attempt could be made to remove the oil or débride patients until the first or second day after admission. Local treatment was, therefore, necessarily applied over the oil. Reasonably efficient tanning nevertheless resulted. Inability to secure early and efficient cleansing of the burned area is the main difference between war burns and burns encountered in civil practice. During an engagement, nothing more than advanced first aid is possible.

As soon as the necessary cradles could be obtained, each severely burned patient was placed under a heat cradle, several blue electric lights being used to supply the heat and the cradles covered with blankets. Blue lights were used because wards had not been previously blacked out and a total blackout was imperative.

This work continued throughout the day and night for about ten days, doctors, nurses and corpsmen working in relays. At night, the only light available in the wards

was the faint blue light given by flashlights equipped with blue glass. This naturally slowed up work seriously, especially intravenous medication.

By the third day, reorganization of patients was accomplished and similar cases gotten into the same ward. Teams of corpsmen were organized and rapidly trained to cleanse patients, débride wounds, do minor dressings and force oral fluids. A number of convalescent patients, seamen, electricians, machinists, etc., who were in the hospital before the air raid joined in this work and did exceedingly well. This is a very good example of what the lay worker, such as nurse's aid, can do on such occasions. Great difficulty, however, continued to be experienced in removing the fuel oil from patients as no suitable detergent could be found. It was later found that the removal of fuel oil could be expedited by the use of a gauze or cotton sponge saturated with mineral oil. This readily removes the thick black oil but also leaves a thinner oily film which may require removal. This latter step is more easily performed.

By the third day also, considerable quantities of human wet plasma had become available to replace the dried plasma which had been on hand prior to the raid, all of which had been used. This wet plasma was presented from the blood bank at Queen's Hospital, Honolulu. Hundreds of citizens volunteered to give blood for this purpose. The wet plasma was invaluable as it filled in the interval between the dried plasma which had been on hand before the raid and additional dried plasma later received by airplane from the mainland.

As more plasma became available, some two-thirds of the medical personnel, assisted by rapidly and specially trained corpsmen, commenced giving plasma to the great majority of patients with burns. At this stage, failure of the tanning treatment was seen on the severely burned patients. There had been such a great loss of fluid through the skin that the eschar had become macerated and in many areas completely rubbed off. In some cases, the loss

of fluid was so great that the patient would be found lying in a regular pool of his own fluid.

It must again be remembered that, in addition to the early scarcity of plasma for such a large number of patients, practically all treatment had to be given during the daylight hours. There was no proper provision for a ward blackout for the first week and the only light available was the dim blue light from a flashlight. Because of this very poor night light and extensive burned areas with constricting or collapsing surface vessels, intravenous medication after dark was most difficult but was nevertheless accomplished.

As the eschar was removed, different forms of local treatment were tried: gentian violet spray, sulfanilamide in mineral oil, wet dressings and open exposure under a heat cradle. There was no apparent difference in the results but it was found that almost any kind of dressing that was allowed to dry on the burns defeated its purpose as it would become foul in twenty-four hours and required removal. This removal, besides causing considerable pain, would leave raw, bleeding and infected surfaces.

The fourth and subsequent days, treatment was practically the same. Cleansing the patient in the morning, débridement, further application of local treatment, more and more plasma, and intravenous fluid.

It is well to note here the difficulty of giving intravenous therapy to badly burned patients. The cubital veins could not be seen or felt in many instances because of the great amount of edema, but in spite of the apparent impossibility of finding these veins, we did find them and did for many days give therapy in this way. In only a few cases was it necessary to cut down on the veins and in some that were cut down on, the patients were in such poor condition that you could not get your solution to flow. The femoral vein was the only one we were always certain of finding because everybody wore at least a pair of trunks and this area was not burned. This

vein was used in a number of cases and in a smaller number the jugular vein but in none of these were the veins exposed. With such continuous intravenous therapy over a considerable period of time, conservation of all available veins was most important. As their blood pressure improved, the veins on the feet and ankles became more prominent and were also used.

During the first week following the emergency, our laboratory was practically out of commission as the technicians had been assigned duty in attendance of the very sick patients. When it went back into commission, we endeavored to get an estimation of the kidney function, the red blood cell counts and the serum protein estimation. It was found that although practically all the serious cases showed albumin in their urine, there were comparatively few that showed evidence of any great kidney damage. Approximately three patients passed bloody urine for several days.

The great importance of an early supply of plasma and fluids for patients extensively burned was impressed upon the entire staff. The loss of plasma with consequent blood concentration, serum protein depletion, and reversal of albumin-globulin ratios make replacement essential. It is of the greatest importance to check the patient's hemoglobin concentration. The figure of 115 to 120 per cent requires 250 c.c. of plasma to restore the concentration to normal. In giving plasma to these cases, no reactions were noted following the commercial dried plasma but a number were observed following first use of pooled wet plasma. This was undoubtedly because the first wet plasma supplied was prepared so hurriedly to meet the unprecedented demand that a good deal of the plasma contained red blood cells and fibrin. As the work progressed, the plasma became better and fewer reactions were noted. Wet plasma should be filtered before use in order to remove any fibrin which may be present.

Chemotherapy was used quite extensively after the first two or three days. Some patients developed a temperature which was considered to be due to local infection. These were given 1 Gm. of sulfanilamide every four hours until the temperature had been normal for several days. This form of treatment seemed to be most beneficial. After the fourth or fifth day, sulfanilamide dusting powder was also used on the raw, infected surfaces and kept moist with wet saline dressings. This appeared to do as well, if not better, than anything else available.

After some ten days of intravenous therapy, some patients showed a marked secondary anemia. These were given 500 cc. of whole citrated blood. In a few cases, these transfusions had to be repeated several times.

After the first week, fairly heavy doses of vitamin c and thiamin chloride were given. This was continued until the case was closed. As soon as the patient could eat, a high vitamin, high protein diet was prescribed.

Before giving our statistical report, it is well to point out that while the treatment that has been described may be criticized, we think that under the circumstances, the rapidity of the admissions, the unheard of numbers of severely burned patients being admitted to one hospital in such a short period of time and consequent lack of sufficient plasma, the results would compare favorably with any other type or types of treatment even though prepared for it, for any type of elaborate ideal treatment would have to be abandoned under such circumstances.

Of the 254 burned patients admitted, approximately thirty-eight died within the first thirty-six hours and of these thirty-eight, twenty-seven died within the first twelve hours.

	Per Cent
The percentage of death to total admissions.....	27.5
Corrected for those that died in first 12 hours...	16.7
Corrected for those that died in first 36 hours...	12.5

Of the 216 patients who were alive after the first thirty-six hours, there were approximately ninety in a serious condition, with from 40 to 70 per cent of the total skin surface burned to a second or third degree. Of these ninety cases there were twenty-seven deaths, or 30 per cent.

We know that this mortality rate of 30 per cent seems to be high but it must be remembered that all of these ninety patients were seriously and very extensively burned, that comparatively little plasma was available for the first forty-eight to seventy-two hours and that they were all admitted within twelve hours. If the admissions had covered a period of several days, it is thought that this mortality could have been reduced by 50 per cent, but it is also thought that even with ideal therapy, there will always be a mortality of 15 to 20 per cent in severely burned cases.

An estimate of the amount of plasma that we would have needed for ideal plasma therapy is as follows:

First 24 hours—360 units of 250 cc. each or 90,000 cc.
Second 24 hours—270 units of 250 cc. each or 67,500 cc.
Next four days—270 units of 250 cc. each or 67,500 cc.
Next seven days—270 units of 250 cc. each or 67,500 cc.
or a grand total of 1170 units.

These figures are considered to be minimum.

Some of our patients ultimately received a total of 8,000 to 11,000 cc. of plasma.

Before the raid, both the Army and Navy thought that they had sufficient dried plasma on hand. I had 500 units. But we had no conception of the enormous number of severely burned patients we would be called upon to treat nor the tremendous amount of plasma that would be required. In estimating the amount of plasma that you should have immediately available at a hospital in an area exposed to enemy air raids, estimate the amount you think you will need, add what you consider an adequate reserve, and then multiply that by three; then you will have about what you really need.

There have been several formulas given to be followed in the administration of plasma. These are based on the hematocrit reading and the plasma protein level. One of the doctors at Honolulu said after December 7, 1941, that if he had a big plasma bank and a good bookkeeper, he could follow these formulas. During or just after an air raid attack or in the field and on board a ship in action, however, one either cannot obtain or must distrust these readings. I would like to say that I have not yet seen a report in medical literature of death attributable to an overdose of plasma.

The Bureau of Medicine and Surgery, Navy Department, has issued some very simple practical instructions for the administration of plasma in cases of severe burns. These are as follows:

- a. May be administered before any laboratory work is done.
- b. Always give in divided doses.
- c. Amount required during first twenty-four hours:
 - (1) 10 per cent of surface burned, 1,000 cc.
 - (2) 20 per cent of surface burned, 2,000 cc., and so on.
- d. If possible, do hematocrit determination. For each point above 50 per cent cells, give 100 cc. of plasma.
- e. Always give intravenously.
- f. Repeat as indicated.

Some time after the air raid, we received a small amount of the recently developed solution for local treatment of burns, triethyldiazine or 2½ per cent solution of sulfadiazine in 8 per cent triethanolamine. It is applied as a spray. This had been widely heralded but was not immediately available to us locally. A great opportunity for comparative study was missed but the future may offer it again. We did, however, later use it on two burned patients and our observations are given for your information.

These patients had only 5 to 10 per cent of the body surface burned and that only to a first and second degree. The results obtained were very satisfactory. After a pre-

liminary careful cleansing and débridement of the burned areas, the sulfadiazine solution was sprayed on, every hour for two days and thereafter every two or three hours as necessary. After the first two days, a nice semitranslucent film was formed over the burned surface. This film remained on until the burned surface was healed. There were only one or two small areas that showed any evidence of infection and by cutting a window at this site and spraying hourly for a day or two, the infection was controlled.

In our opinion, some of the advantages of this sulfadiazine solution for local treatment of burns are: (1) A nice, clean, semitranslucent, pliable film is formed covering the burned area so that it can be seen through and the condition of the burned surface followed; (2) apparent relief of pain; (3) resistance to local infection; (4) apparent prevention of loss of fluids; and (5) it may be used about the face or genitalia and does not cause constriction of fingers or joints.

Some of the disadvantages are: (1) The extreme care necessary to cleanse and débride the burned area takes considerable time; (2) the time required for the necessary repeated sprayings before the film is formed over the burned area. In our opinion, this is an excellent treatment for burns but these disadvantages will probably prevent this treatment from being used where there are any considerable number of patients with extensive burned surfaces.

SUMMARY OF LATEST INFORMATION ON TREATMENT OF WOUNDS AND BURNS

At this point, a summary of the latest information on the prevention of infection in wounds and the treatment of burns as recommended by the National Research Council is given:

"Sulfanilamide is the drug of choice for local or parenteral therapy and sulfadiazine for oral therapy.

"(a) Locally, crystalline sulfanilamide is preferable to the powdered drug but the

latter should be used if the crystalline form is not available.

"When used locally, sulfathiazole tends to cake, may act as a foreign body and obstructs drainage of wound secretions.

"(b) Parenterally. A 1 per cent solution of sulfanilamide in sterile physiological saline solution may be given, usually under the fascia on lateral side of thigh, 150 cc. every six hours for four to seven days after operation.

"This solution should be boiled for 5 minutes to sterilize and then cooled to 37°C.

"Dry sulfanilamide, crystalline or powdered, should be sterilized before use by exposure to dry heat for a period of 2 hours at a temperature of 156°F.

"A 5 per cent solution of sodium sulfadiazine may also be used. It is not to be sterilized. The initial dosage is 0.1 Gm. per kilo of body weight. Subsequently, .03 Gm. per kilo of body weight may be given every 12 hours for 4 days.

"Sulfathiazole and sulfapyridine may also be given in 5 per cent solution intravenously but not subcutaneously.

"(c) Orally. Two Gm. of sodium sulfadiazine should be taken in one dose orally, immediately after the wound is received. Following this, 1.0 Gm. should be given every 6 hours. In order to maintain a proper blood level of the drug, it should be given around the clock. This treatment should be continued for 7 days at which time, if the wound is clean and there is absence of fever attributable to infection, oral therapy should be discontinued. If the wound is infected, treatment should be continued as indicated.

"For penetrating or through and through wounds, prepare a suspension of sulfanilamide crystals in sterile physiological saline solution. Sulfanilamide solubility varies greatly, from .75 Gm. in 100 cc. at 25°C. to 47. Gm. in 100 cc. at 100°C. Such a suspension of the crystals can be used as a means of introducing sulfanilamide into deep wounds.

"The suspension should be made up at the time of use and the syringe containing it should be rotated while it is being introduced into the wound in order to maintain the suspension.

"When gauze drains or wicks are used, moisten them in sterile saline solution and dip in crystalline sulfanilamide before being introduced into the wound.

"After any wound is redressed, it should be 'frosted' with crystalline sulfanilamide at each dressing until healed."

Our first aid packets now contain a small amount of crystalline sulfanilamide to be dusted on a wound by an injured man. They also contain 1 Gm. tablets of sulfadiazine with instructions for taking same, commencing promptly after being wounded.

It has been stated that sodium sulfadiazine may only be used intravenously and not intramuscularly or subcutaneously because it is highly alkaline and may cause a slough. Five per cent solution of sodium sulfadiazine has, however, been frequently used at the Children's Hospital, New York City, by Dr. Gilbert M. Jorgenson and others without a slough resulting. It appears that the statement that sodium sulfadiazine could not be used subcutaneously because of its high alkalinity is based on a misconception of the buffering or neutralizing effect of tissue fluids upon sodium salts of the sulfonamides. While sodium sulfadiazine is highly alkaline in a bottle or test tube, in practice it does not act "highly alkaline" nor cause a slough when used intramuscularly or subcutaneously.

Neither powdered sulfathiazole or sulfadiazine are satisfactory as local treatment for wounds. Sulfathiazole, especially, cakes and prevents drainage of wound secretions. Fox and Rose, at the College of Physicians and Surgeons, New York, have shown, however, that sodium sulfadiazine is as good or better than sulfanilamide locally. Considerably less is required and large amounts do not produce the complications possible with excessive use of sulfanilamide.

BURNS

The recommended treatment of burns continues in a state of flux, as has been the case for years.

Burns of the hands, face and genitalia should be treated by application of an aqueous emulsion of 5 per cent sulfadiazine. If this is not available, use boric acid ointment or other similar preparation. Cover burned areas with fine mesh gauze, 44 mesh per inch if available. Firm bandage and cotton waste should be applied to hands. Do not bandage face or genitalia.

The tannic acid method of treatment for burns of the trunk, arms and legs is losing ground in Great Britain and this country, the chief reasons being the locking in of infection, difficulty in removal of eschar under these conditions, interference with skin grafting in third degree burns as a result of loss of vital epithelium from action of the tannic acid, and the possible hazard of liver damage incident to the toxic action of the coagulant.

An important addition to the treatment of burns is an ointment recently developed by Dr. Charles L. Fox, Jr., of the College of Physicians and Surgeons, New York. This ointment has an anhydrous base and contains 5 per cent tannic acid and 2.7 per cent sodium sulfadiazine. This is alkaline and has a hydrogen ion concentration of 7.5. In 1932, Stanley J. Seeger wrote of the high degree of edema produced in tissues by solutions in the acid ranges and stated that the best results are obtained at the hydrogen ion concentration nearest 7.4. The hydrogen ion concentration of the water soluble 10 per cent tannic acid, 5 per cent sulfadiazine jelly used in treatment of burns is 2.55. The 7.5 hydrogen ion concentration of Fox's jelly is very near the ideal of 7.4 as stated by Seeger.

Use of Fox's jelly is still somewhat in the experimental stage in that there have not been sufficient severely burned patients in this vicinity to treat with it. I have seen it used, however, on a number of severely burned experimental rabbits and personally

I like its action much better than either the tannic acid-silver nitrate spray or the 10 per cent tannic acid, 5 per cent sulfadiazine jelly. Fox's jelly produces a rather thin, quite pliable and soft but firm eschar over the burn. This is not adherent but moves freely over the underlying tissue. The burned area is dry, there being no edema nor oozing or weeping of serum. Removal of small sections of the eschar showed a clean healing surface beneath. The eschar was sufficiently tough to resist removal and none had been rubbed off by the rabbits. The sulfadiazine controls infection.

I have been informed that the Subcommittee on Burns of the National Research Council was impressed with the results of Dr. Fox's preparation and voted at its last meeting to recommend discontinuing the use of tannic acid jelly for the first aid treatment of burns, since it was believed that there was little opportunity for proper débridement in the field and consequent danger of infection. It is presumed that the Committee will go on record in favor of some other technic in the near future.

After Pearl Harbor, we used different methods of treatment in different wards where burns were treated. Our observations showed that there was little, if any, difference between them. One day, the patients in one ward looked better and the next day, those in another ward seemed the best.

The majority of our staff preferred the tannic acid-silver nitrate spray. In this, a freshly prepared 10 per cent tannic acid solution is sprayed over the entire burned area, followed immediately by spraying with a solution containing equal parts of 10 per cent tannic acid and 10 per cent silver nitrate. This last solution is applied every half hour for four applications.

With infected burns, however, after they have been cleaned with normal saline, the local application of crystalline or powdered sulfanilamide kept moist with warm normal saline compresses renewed every three or four hours gave excellent results. It is recommended that not more than 15 Gm.

of sulfanilamide be applied in any one twenty-four period.

Sulfadiazine spray will also clear up an infection but requires frequent spraying and is impractical for mass casualties. Powdered sodium sulfadiazine locally controls infected burns promptly. Fox's jelly will also clean them. Various sulfonamide impregnated "films" have been manufactured for use on burns. While these are full of possibilities, those known to me have not been successful in controlling infection in burns, apparently because of an insufficient sulfonamide content. Fox's jelly has successfully controlled these infections. Examination of exudate from beneath the eschar of infected burns at the College of Physicians and Surgeons has shown 130 mg. per cent of sulfadiazine in patients treated with this jelly and none in patients treated with other preparations.

An extremely interesting new light on the treatment of burns has recently been reported. This is that burns of patients whose ships had been sunk and who had been overboard for several hours before being rescued, were in appreciably better condition than burns of patients who had not been overboard. The highly salt seawater is quite bactericidal and had a definitely beneficial effect upon the burns. The saline content of sea water is a little more than three times that of normal saline solution.

Many extensively burned patients are now treated with hypertonic (double strength) saline solution locally and excellent results obtained. The burned area is loosely covered with a single or double thickness of gauze, frequently only tossed on like a fluff, and the saline solution sprayed on frequently so that the area is kept moist. Once and sometimes twice a day, circumstances permitting, the burned area is given a tub bath or soak of a half hour or an hour in the hypertonic saline solution.

In case of an infected burn, sulfanilamide or sodium sulfadiazine may be used locally with the hypertonic saline solution as

previously described with normal saline solution.

For removal of fuel oil from burned areas, any one of three detergents obtainable commercially are recommended. These are Dreft, Drene and Orvus. All are used in 5 per cent solution.

With all severe burns, 500 cc. of blood plasma should be given at the first aid or casualty clearing station if possible before evacuation to the hospital.

Concentrated human serum albumin may be used in place of blood plasma. If used, 100 cc. is equivalent to 500 cc. of plasma. It is given intravenously.

When physiological glucose and saline solution are given to burned patients, the amount given should not exceed the amount of plasma given in twenty-four hours, except in those instances in which there is severe hemoconcentration—a hematocrit reading of about 70 per cent cells.

BLAST INJURY OR CONCUSSION OF THE LUNG

These cases, while not very numerous, were extremely interesting. Nineteen were admitted between December 7 and 11, 1941. Twelve were mild cases and were returned to duty in from five to seven days. Three were moderately severe but were returned to duty in from seven to ten days. Four cases were severe.

All of these patients exhibited varying degrees of severity and differing combinations of the following symptoms: shock, restlessness, labored breathing with diminished air intake, cough, cyanosis and blood streaked or frothy sputum. All had been in the vicinity of high explosive blasts and, in addition, many had inhaled dense oil smoke for considerable periods. Because of this fact, these cases were at first considered to be smoke inhalations but later, because of the symptoms and clinical course, considered with the situational etiologic agent (blast from high explosive), were diagnosed as blast injuries to the lungs as described by various military observers in England and Europe. The

four severely ill patients had a clinical course not unlike lipid pneumonia.

The outstanding lesion of this condition is pulmonary hemorrhage resulting from the impact on the body wall of the positive pressure wave created by the detonation of high explosives. This wave has a velocity of about ninety miles a minute. There is rupture of the pulmonary capillaries and alveolar walls and the air sacs are filled with red blood cells. There may also be subarachnoid hemorrhage.

Marked restlessness and excitement is a prominent symptom while the shock is out of all proportion to the apparent degree of injury. The physical symptoms vary greatly but limited respiratory excursion, with limited air intake and coarse or sibilant râles throughout the lungs are the usual findings. X-ray examination shows a characteristic mottling, poorly demarcated areas of increased density scattered throughout both lungs, somewhat resembling a patchy pneumonic consolidation or miliary tuberculosis. The severity of the injury and, therefore, of the symptoms, is directly proportional to the distance between the individual and the explosion.

That this condition may cause almost immediate death is shown by the fact that some twenty casualties found to be dead upon arrival at hospital had no external evidence of injury other than a bloody froth about the lips. Some six others who died within a few hours after admission had no external evidence of violence. No autopsies could be performed on these cases because of the great pressure of work in caring for the living.

Review of the literature on this subject shows that the sound waves of the pitch that predominates in explosions of large bombs may be as long as thirty feet and of considerable amplitude. Pressures up to 200 atmospheres or about $1\frac{1}{2}$ tons per square inch have been observed in the compression part of the wave. In 1940, Zuckerman proved that a sudden elevation of pressure, retarding the expulsion of air from the trachea and forcibly compressing

the body walls, could rupture the delicate pulmonary tissues.

Early recognition of this injury should be emphasized because the patients are at first not likely to be considered seriously ill and because of the value of early rest and oxygen therapy. Several of our patients would have died without oxygen.

Treatment of these cases was chiefly symptomatic, viz: morphine sulphate and codeine for restlessness and cough; oxygen for respiratory difficulty and cyanosis; forced fluids and strict bed rest.

COLLATERAL ACTIVITIES

A very important part of our staff was the Chinese galley force. Midday on December 7th, they worked until 3:00 P.M. cooking and serving dinner to 4,500 persons. They then immediately started getting supper ready. Not only the hospital staff but all defense personnel in the vicinity of the hospital were fed by us. A renewal of the Jap attack that afternoon or night had to be anticipated and it was imperative that our defenses not be weakened by men going any great distance for meals.

An extremely important part of our work on December 7th and for several days afterward was identification of the dead. The hospital acted as a clearing house in this respect, all bodies being brought there for identification prior to burial. We prepared lists of dead and the detail having this duty worked twenty-four hours a day for several days in order that the lists might be sent to the Navy Department as soon as possible.

SUMMARY

What happened at the Naval Hospital at Pearl Harbor, may happen to any hospital anywhere in an area exposed to air raids. It used to be said in Pearl Harbor, "It can't happen here." But it did happen there and it can also happen in New York.

A well organized, smoothly running team is as important in efficiently caring for war

wounds as it is in scoring touchdowns on the football field.

The wounds produced in an aerial attack must all be regarded as serious because wounds produced by aerial bombs are usually multiple and almost invariably very severe. While competent surgical treatment is required as soon as possible, remember that surgery cannot be done under these circumstances or in the field as it would be done under conditions in civil life. Our first object is to save life (1) by controlling hemorrhage, (2) by allaying shock, and (3) by every possible effort to prevent infection.

Competent surgical treatment may be promptly available or it may not be available for several days. Local use of sulfanilamide in wounds has removed the old bugbear of military surgeons, the development of infection in the wound. The development of dried blood plasma now permits the administration of plasma on board ship and in the field, thus saving many lives which would previously have been lost.

In the field, casualties may be grouped in three classes: (1) Those killed outright or so seriously wounded that they die within a short time. When there are many casualties, little time should be given these hopeless cases. (2) The slightly wounded who will recover regardless of the type of emergency treatment. Most of these can be rapidly treated and returned to duty. (3) Those with more serious wounds who have a good chance of recovering providing adequate treatment is available. The lives of many of these patients rest entirely in the hands of the man doing the emergency dressing and it is what he does or fails to do that frequently makes the difference between life and death.

A large percentage of the patients with wounds of the head and trunk die on the field. About three-fourths of all casualties received in hospitals have wounds of the extremities.

Emergency treatment of external hemorrhage is generally understood by all.

Laymen should be especially cautioned concerning use of the tourniquet, however, as it can be extremely dangerous. Applied too long at a time, gangrene results; applied too tightly, it causes a great deal of tissue damage and acute symptoms of shock may develop when it is released. The tourniquet should not be used until all other methods have failed.

The treatment of shock should start before its onset. Waiting for the clinical picture of shock to develop before instituting treatment invites disaster.

The best field preventive of shock is blood plasma. The powdered plasma can be easily prepared for use by the addition of distilled water and need not be warmed prior to injection. Plasma should be given all seriously wounded patients as soon after injury as possible, certainly immediately after receipt at the first casualty clearing station. Transfusions of plasma within this zone will do more to reduce mortality from shock than any other single factor. All members of field medical units should thoroughly understand the administration of dried plasma.

Evacuation of the wounded is frequently a difficult problem in the field and considerable judgment must be exercised in picking out the urgent cases for primary evacuation. Ordinarily, patients with abdominal wounds should be evacuated first, then those with head wounds, chest wounds and wounds of the extremities.

It is most important to label patients conspicuously or mark them on the skin before evacuation to hospital so that the next person treating them will know when a tourniquet was applied, when morphine was given and dose, etc.

Some confusion will inevitably exist in the best of hospitals, prepared or unprepared, upon receipt of such an avalanche of patients as may be expected following an air raid. The following points are suggested to remember in connection with handling a large number of war wounded, unexpected or otherwise.

Hospitals properly prepared for casualties should have ample supplies of material readily available—many times the amount needed for normal times. Until you actually experience it, you simply cannot realize how rapidly supplies of all kinds, surgical dressings especially, disappear, for the wounds are frequently multiple and often of great size.

Patients should be admitted to the hospital at but one entry if at all practicable, so that their injuries can be quickly examined and their disposition made without unnecessary delay. It is also important that certain wards or groups of wards be designated for treatment of certain classes of casualties: acute surgical, fractures, burns, etc., and equipped accordingly.

If practicable, one doctor should rapidly examine casualties on admission, tag them in accordance with the nature of their injury and send them to their proper place in the hospital.

This job is really very important and should be filled by a surgeon of wide experience and sound surgical judgment. He should have adequately trained assistants. Casualties may have multiple injuries and a large wound may not be nearly as serious as one difficult to discover.

All injured patients on entering hospital fall into one of five categories: (1) Those needing treatment for shock; (2) those in need of minor surgical assistance; (3) those needing major surgery immediately; (4) those needing surgery later or not at all, and (5) those beyond surgical assistance.

The admitting doctor should quickly but accurately survey the casualty and write on his forehead in mercurochrome the number indicating into which of these categories the patient falls.

It is also desirable, if practicable, that the patient be tagged at this time with a card giving his name and previous medication. Actually, this cannot be done in practice if a flood of casualties is arriving as was the case with us at Pearl Harbor. We started to tag our casualties upon arrival

but it took too much time and we quickly stopped it.

It is quite desirable to detail a surgical consultant to go about the wards and designate patients for transfer to the operating room in accordance with the condition of the patient and the availability of operating space. It is better for patients to await surgery in their wards than to clog approaches to operating rooms.

When possible, it is best not to remove the patient from the stretcher, on which he is placed when first picked up, until he is finally deposited in his ward bed. This lessens possible shock. Immediately necessary treatment for shock may easily be given with the patient on a stretcher. Major operations can also be performed with the patient on a stretcher.

We followed this procedure to a considerable extent at Pearl Harbor, the ambulance drivers being given other stretchers to replace those under patients in order that they might immediately return for more casualties. This scheme of course required many stretchers but we had a good many on hand and our carpenter shop rapidly made more.

If any large number of injured is to be cared for, it is important that a special ward or wards be designated for the treatment of shock, that its staff be especially competent to administer such treatment and that it be adequately equipped with ample apparatus for this purpose. Wards for burned patients should be similarly specially equipped for burn therapy. We were considerably handicapped by an inadequate amount of these supplies immediately available. Once again, we had not anticipated such a flood of patients as we received. Valuable time was lost in obtaining necessary additional equipment from the storeroom. Our immediately available supply of stands to support infusion apparatus gave out and the carpenter shop had to make extemporaneous stands rapidly. But although we had to struggle and extemporize, the patients nevertheless got their needed

treatment with reasonable promptness and no harm was done.

The importance of the Orr-Trueta plaster cast treatment for extensive wounds of the extremities was emphasized at the Naval Hospital, Pearl Harbor, and in evacuation of patients to the mainland. This treatment was used considerably in the late war in Spain and by the English in the present war. After Dunkirk especially, the English stated that wounded soldiers treated by this plaster cast method before evacuation reached England in much better condition than similar cases in the last war. Local use of sulfanilamide on the wound before applying the plaster has brought even better results. Plaster immobilization of extremities after severe wounds with or without fracture very definitely relieves pain and promotes healing. With this treatment, patients can be transported in comparative comfort while their wounds improve instead of possibly becoming worse.

An excellent substitute for a plaster splint in the field is a papier-mache splint which I was recently shown. This splint dates from the closing days of the last war, when a French countess, working in a Casualty Clearing Station, heard French Army doctors talking of the number of cases of serious compound fractures who developed severe shock and other complications as a result of careless and badly handled splinting by Ambulance Corps and First-Air parties.

An inexpensive, readily transported splint, easily and quickly applied, was needed and, with the aid of sketches supplied by doctors, the Frenchwoman evolved this paper splint.

At the beginning of this war, the French Air Force demanded a light splint that supplied rigidity and immobilization for temporary splinting of badly injured aviators. Upon hearing of this need, the daughter of the inventor communicated with the War Office and, after official investigation and tests, the paper splint was adopted by the Ministry of War.

The British became interested in these splints and started making them. Some were very successfully used in the Norway campaign. One patient had his fractured leg in one of these splints four days before he finally arrived at a hospital. Upon arrival there, both leg and fracture were in good condition.

These splints are made for compound or simple fractures of the long bones, and for right and left arms and legs. A metal or heavy cardboard mold is made of proper dimensions and contour to fit a limb. The splint itself has a base of light cardboard such as cigarette cartons, or heaviest quality Manila paper. This base is cut the shape of the mold and soaked in water for a half hour. It is then fitted in the mold and allowed to dry.

After drying, the molded splint base is covered on both sides by irregularly torn pieces of waste paper about four inches square, overlapping each other about $\frac{3}{4}$ of an inch. The pieces of paper are pasted on the splint base, a thin coating of paper-hanger's paste being commonly used. The edges of the splint are similarly covered with pieces of paper.

Tapes, usually selvage edges discarded in bandage making, are placed around the outside of the splint, under the outer paper covering. For arm splints, they are placed three inches from each end. With leg splints, a third tape is placed around the middle. The ends of these tapes are brought out through the outer paper layer, about 3 inches from the edge. This permits overlapping of the edges of the splint if necessary.

When thoroughly dried, each side of the splint is given a single coating of spar varnish or shellac in order to make it waterproof and impervious to the elements.

Traction splints for the leg may be made by including a narrow lath bolted to each side under the outer paper layer. These extend about 6 inches beyond the foot of the splint and the ends are connected by a small cross bar to take the traction. Countertraction is obtained by the upper end of

the splint which fits the upper thigh, lying posteriorly in the fold of the buttock.

These splints are exceedingly cheap, can be made anywhere, and require no critical materials nor ship transportation. A half dozen can be nested in each other and fastened under the top of an ambulance for use when needed. They may be padded with clothing, grass or anything available. They are purposely made large to allow for swelling of the limb. They have the advantages of a plaster splint without the disadvantages, being light yet strong and giving complete immobilization without danger to fractures. They are very difficult to distort or destroy and are absolutely safe in the hands of inexperienced persons. They may be used for large wounds or burns of the extremities as well as for fractures.

One of the most important lessons learned at Pearl Harbor was the imperative necessity for hospitals or any medical activity in areas subject to enemy air attack to provide themselves with large stocks of reserve medical supplies, sterile gauze, shell dressings, etc., and to scatter these in several of the most widely separated and best protected rooms or spaces available. The necessity for these things is of course readily apparent—to prevent loss of all medical supplies or all main operating facilities by one direct hit. One of my chief worries at Pearl Harbor was my operating pavilion that stuck out like a sore thumb. I was constantly worried lest some Jap should take it into his head to drop a bomb through it. I was most unhappy about possible future raids until I had three complete operating rooms established, one at each end and one in the middle of the basement of the hospital where they were sufficiently protected by reinforced concrete and sand bags to stand at least one direct hit.

A very important detail is to simplify technic as much as possible. This is essential for handling mass casualties. Streamline your technic. Since December, 1941, I have seen hospitals which were organized for possible air raids but whose burn teams

were trained to carry out an elaborate technic that would inevitably break down in the presence of such a flood of seriously burned casualties as we received during the air raid at Pearl Harbor. Remember that in the treatment of masses of war burns, the same principles must apply that apply to other classes of wounds. The immediate treatment can only be advanced first aid—administration of morphine, treatment of shock and prevention of infection. Administration of plasma to severely burned patients must be started with the least possible delay. Local treatment, cleansing, débridement, local applications, are of course all desirable and important but they require considerable time and can wait. The immediately imperative necessity is treatment of shock. Local treatment can be carried on at the same time or as soon afterward as practicable.

In closing I would like to say a word about my hospital staff at Pearl Harbor at the time of the raid. I was proud of them all and especially proud of my nurses and hospital corpsmen, many of whom were youngsters who had been in the service a comparatively short time. They stood their baptism of fire well. When the Jap planes roared over and around us, they dashed from their quarters to the main hospital building through a shower of anti-aircraft shell fragments and stray machine gun bullets. Their first thought was to care for their patients and to get ready for those we knew would soon be coming. Though occasional shell fragments and machine gun

bullets zipped through our temporary ward buildings, everybody was so busy that they had no time to think of themselves and fortunately nobody was injured. After the raid, all hands worked until they dropped, the nurses especially. I will always remember my chief nurse, a frail appearing little woman who looked as though a good gust of wind would blow her away. But she was made of steel wire. She was everywhere, encouraging, supervising, directing. Three days after the raid, it was necessary to order her to go to bed and get some sleep.

At midnight of December 7th, we had 960 patients in a hospital whose official rating was 506 patients. The next day we received almost a hundred more who had been temporarily cared for at outlying activities.

The hospital staff took great pride in the fact that, though understaffed for such a great number of serious casualties, we had anticipated our needs and were able to care for our own in this emergency without any outside medical assistance except some volunteer trained nurses from Honolulu.

The Naval Hospital, Pearl Harbor, was given the unusual distinction of being cited by the Commander in Chief, United States Pacific Fleet, for distinguished services during and subsequent to the Japanese attack on December 7, 1941.

The opinions or assertions contained in this article are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.



MELANOMA

A REVIEW OF THIRTY-TWO CASES ADMITTED TO THE BROOKLYN CANCER INSTITUTE DURING A FIVE-YEAR PERIOD

WILLIAM E. HOWES, M.D.

Clinical Director, Brooklyn Cancer Institute

AND

MILTON BIRNKRANT, M.D.

Resident Radiologist, Jewish Hospital of Brooklyn

BROOKLYN, NEW YORK

MELANOMA can be defined as a malignant tumor derived from pigment producing cells. Naevosarcoma, melanosarcoma, malignant naevus and naevocarcinoma are other terms used to describe this lesion. Naevus or mole, on the other hand, represent a benign process; they are congenital and are closely associated with the melanomas both from their gross and microscopic appearance. The term naevus is used interchangeably and may be used to designate a pigmented mole, a hemangioma (a vascular lesion) or a lymphangioma (a lymphoblastic tumor).

RELATIONSHIP OF PIGMENTED MOLES TO MELANOMAS

Fifty-four per cent of the skin melanomas to be reviewed gave a history of having had a pigmented mole at the site of the lesion "all of my life." This is in agreement with other observers, as Pack and Livingston,¹ who found that "more than fifty per cent of melanomas develop in naevi which have been present since birth or shortly thereafter."

Some investigators consider the common mole a precancerous lesion which may be activated by injury, irritation, inflammation or endocrine stimulation, whereas others subscribe to a modified Cohnheim theory, believing that a melanoma starts as a "quiescent" new growth which consists of congenitally misplaced and potentially malignant cells. These cells may suddenly become activated and develop all the characteristics of a malignant growth due to some unknown factor, intrinsic or extrinsic.

When a pigmented lesion increases in size, changes color, ulcerates, crusts, oozes, bleeds, becomes elevated, itches, pains or exhibits any detectable variation from its usual appearance, malignant activation is to be suspected.

MICROSCOPIC CHARACTERISTICS

Melanin is produced by specialized cells called melanoblasts. These melanoblasts may be demonstrated as early as the fifth month of fetal life by the "dopa" reaction of Block.² The color of a pigmented lesion depends on the location and quantity of melanin present. If it is predominantly epidermal or at the epidermodermal junction, the color is brown; if it is deeper down in the cutis or subcutis it may be blue-black in color. Hemociterin granules are commonly present in these lesions and are difficult to differentiate from melanin. (Fig. 1.)

Microscopically, a mole consists of closely packed collections of clear rounded or polyhedral cells in the dermis, usually at the epidermodermal junction. These clear cells are the so-called "naevus cells." Melanoblasts are fusiform cells often filled with pigment, they are apt to be grouped around these so-called naevus cells.

Melanomas have the general microscopic characteristics of other malignancies. Boyd³ points out that "no tumor presents a more varied picture than the melanoma, and it is not too much to say that it may simulate a carcinoma, sarcoma, endothelioma and even lymphosarcoma." The amount of pigmentation varies markedly. With the absence of pigment, the diagnosis has to be made from the cytological picture alone.

The following theories as to the origin of the melanotic cell are presented: (1) It may arise from some epithelial source. Accord-

per cent of all skin lesions hospitalized in that period. No negroes were among this group.

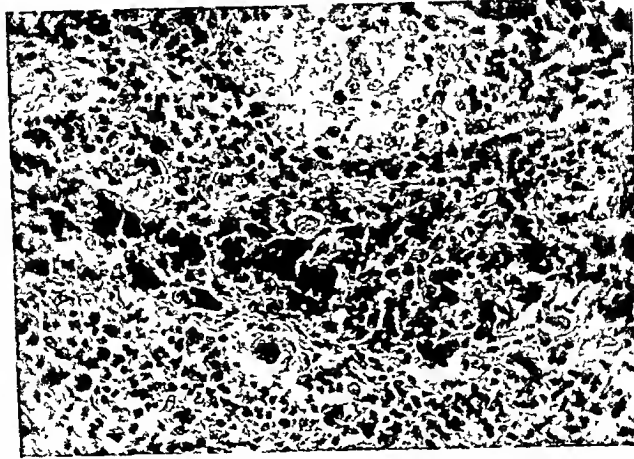


FIG. 1. Microphotograph of a malignant melanoma.

ing to Ewing,⁴ this was first broached by Unne, 1893, and is still attested to by more modern workers. (2) It may arise from the perithelium or endothelium of blood vessels. Demiaville, 1880, (Ewing). (3) It may arise from certain fibroblastic or mesoblastic cells, as the chromatophore. (Ribbert.⁵) (4) It may arise from the nerve cells within the sensory nerve organs, as Meisner's corpuscles and the tactile end organs of Merkel-Ranvier. (Masson.⁶) This latter possibility, i.e., origin of the naevus cell from nerve-end organs is at present widely accepted.

HEREDITARY AND RACIAL FACTORS

Pack¹ has shown that the average individual is born with fifteen to twenty pigmented moles. Their almost universal presence in the skin of all people of the white race would rule out any hereditary familial characteristic.

Melanomas are rare in the North American Negro. According to Baxter,⁷ the relative incidence of occurrence of melanoma in the black and white race is as one to four.

REVIEW OF CASES SEEN AT THE BROOKLYN CANCER INSTITUTE

Thirty-two cases of melanoma were admitted to the Brooklyn Cancer Institute from January, 1936, to March, 1942. They comprise 1.2 per cent of all cases and 11.5

The average age was 52.4 years. There were seven cases under forty-four years of age. The youngest patient was twenty-two

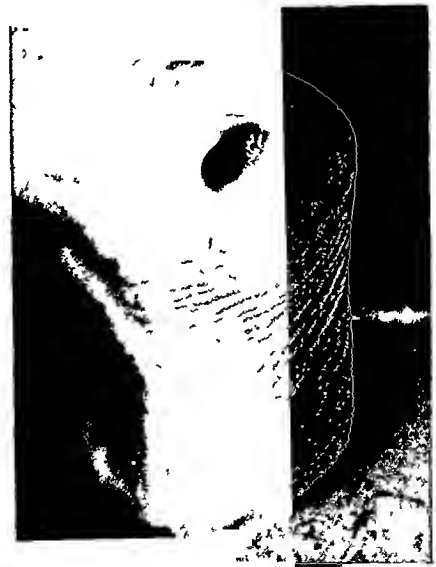


FIG. 2. M. B. Primary melanoma of heel in a thirty-nine year old white female. A mole had been present since birth.

and the oldest eighty years. This age incidence agrees with the findings of other workers. Darier (Cholnoky⁸) states that the average age of various collected cases presented in the literature varies from forty-seven to fifty-five years.

Many observers believe the relatively low incidence of malignancy of these lesions

during infancy and childhood is due to an endocrine factor. The sex hormones, which are most active after puberty, are known to



FIG. 3. W. S. These extensive skin metastases were so radioresistant that although sufficient radon was implanted at the base of some of the nodules to cause them to slough, the tumor recurred rapidly in the necrotic base.

influence pigment production. It is of interest to note in this regard the case report of Parkes Weber,⁹ who describes a case of melanoma transmitted from mother to fetus via the placenta with death of both.

Eighteen (56 per cent) of the thirty-two patients were female and fourteen (44 per cent) were males. This agrees with the sex incidence as reported by Taussig and Torrey,¹⁰ who found an almost equal distribution between the sexes, while Pack and Livingston¹ found a slightly higher per cent of males (55 per cent vs. 45 per cent).

ANATOMIC DISTRIBUTION

In our series the distribution of the primary lesion was found to be:

	No. of Cases
1. Skin	
Extremities	
Lower.....	9
Upper.....	5
Face.....	4
Neck.....	1
Trunk.....	6
2. Miscellaneous	
Eye (choroid).....	6
Rectum.....	1

From these figures it is shown that 29 per cent occurred on the lower extremities and 16 per cent or only half as many on the upper extremities; whereas it is an established fact that pigmented moles are more frequently present on the upper extremities.

Melanomas of the choroid comprised 19 per cent of our cases, the second most frequent primary site. The warning symptom of intra-ocular melanoma is blurred vision or decreased visual acuity. Pain and proptosis are usually late manifestations.

Most of the other lesions were present on the exposed portions of the body and of necessity subject to trauma. One third of the cases reported in this series gave a history of single or multiple injuries to a so-called pigmented mole.

These neoplasms tend to remain dormant for years and after growth is established the individual can often remember some injury. These so-called injuries are apt to be bizarre in character, as for instance, one woman who had had a small black mole on her forearm. A chicken pecked at the mole and shortly after this incident "it started to grow." The activation is frequently ascribed to abrasions and other minor injuries. There are times, however, when the severity of the injury and the time relationship of activation is more convincing as to cause and affect. For instance, one young adult male had his foot severely crushed by a heavy roll of newsprint paper. This was followed a month later by growth in a so-called pigmented mole on the dorsum of his foot. On careful

consideration the location of the lesion on the dorsum of the foot would make it subject to repeated pressure and chafing

danger lies in its metastases. The usual spread is (a) by direct extension into the surrounding tissue, (b) by the lymphatics

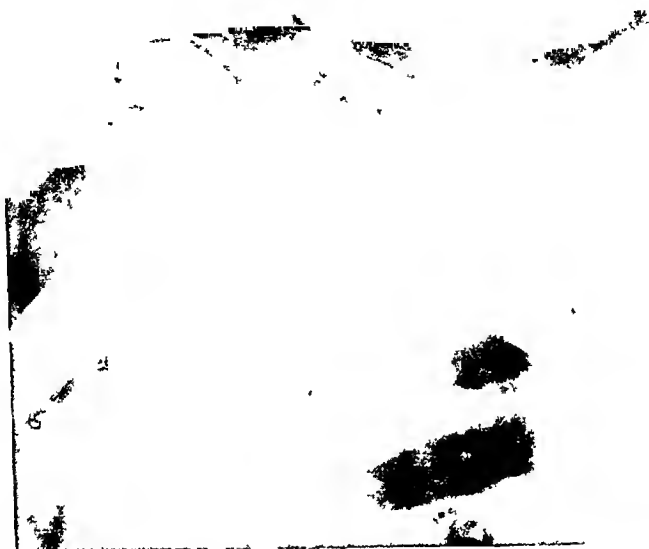


FIG. 4. M. H., a fifty-five year old white female, had a lytic and expansile clavicular metastasis secondary to melanoma of the sole of the foot.



FIG. 5. W. S., a forty-nine year old white male, had skin metastases from a primary melanoma of the sole of the foot. Several minor procedures were done before a biopsy was taken.

from a shoe over the course of years. If the severe contusion was a factor, it could only be the culmination of a series of lesser insults to this so-called quiescent melanoma.

SPREAD

A melanoma seldom results in serious disturbance due to local growth. The

to the adjacent skin and regional lymph nodes and (c) by the blood stream to distant parts (lung and liver). Blood stream dissemination usually occurs late in the disease.

In this series clinically demonstrable regional node metastases were found to occur on an average of 19.2 months after

development of activity in the primary lesion. In some cases, such as melanoma of the rectum and choroid, region node,

DISTANT METASTASES

The following is a list of the distant metastases in the order of their frequency



FIG. 6. J. R., a fifty-seven year old white male, had pulmonary metastases from a primary melanoma of the choroid seven and one-half years after exenteration.

metastases were not clinically demonstrable because of anatomic reasons.

Twenty of the thirty-two cases developed regional node metastases. These metastases were demonstrated in the following sequence of time:

Months.....	3 to 12	12 to 24	25 to 72
Number of cases ..	7	9	4

The shortest time interval was in the case of a young man who developed femoral metastases three months after noticing enlargement of a pigmented mole of his calf. The longest interval was that of a sixty-eight year old female who developed metastases some six years after a melanoma was removed from her upper eyelid.

Regional nodes were the first to be involved, except in three instances: two cases in which skin nodules (skin lymphatics) appeared first, and a third case in which the metastases were first discovered in the lung. (Fig. 6.)

Location of Metastases	No. of Cases	Per Cent
Pulmonary.....	8	25.0
Liver.....	5	15.6
Bone.....	6	18.6
Cerebral.....	3	9.6
Abdominal peritoneum.....	1	3.1
Pelvic peritoneum.....	1	3.1
Retroperitoneal nodes.....	1	3.1
Tongue.....	1	3.1

Distant metastases tended to appear after an average time interval of two years and eight months. The earliest manifested metastases, pulmonary and hepatic, were one case to each of these organs within eight months. The average length of time it took for the four most frequent distant metastases to occur was: liver, 19.4 months; pulmonary, 35.4 months; skull, 50 months; cerebral, 51 months.

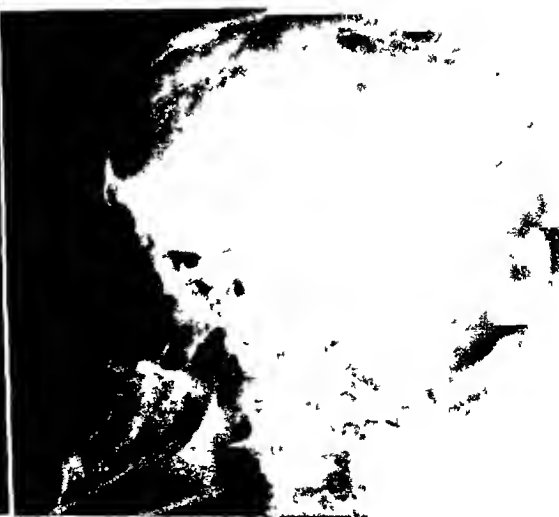
Bone metastases in this group were considerably higher than in other reported series, some of which range as low as 1 per



A



B



C

FIG. 7. S. P. A, multiple rarefying metastases in a forty-nine year old white female; primary melanoma of the rectum; B, metastasis in the third metatarsal bone—an unusual location; c, multiple skull metastases in the same patient.

cent. Six patients or 18 per cent of this series developed bone metastases. The following bones were involved:

Skull	4	
Ribs	2	
Pelvis		
Vertebrae		
Clavicle	} each 1	In 3 cases the metastases to bone was multiple and in 3 cases the bone lesion single.
Scapula		
Metatarsus		
Femur		

The roentgenographic appearance is in no way characteristic. The bone lesions were uniformly lytic in character, round or oval in shape, having a clean smooth edge without evidence of cortical or periosteal reaction zone. The cortical bone is entirely resorbed within the lesion. (Fig. 7A.) Only in one case was there an expansile lesion. (Fig. 4.) Here there was mushrooming out of the head of the clavicle to about twice its normal diameter and with pathological fracture through this expanded shell.

TREATMENT

The table rather dramatically demonstrates the inadequacy of dealing with a melanoma by single or multiple local excisions. There is not a single survival in this group, while with a more radical excision seven out of ten have survived, averaging over five years. It is appreciated that many successful local removals may be performed and that unless there is recurrence the case may never be referred to a Cancer Hospital.

It is the authors' opinion that the routine dissection of the lymphatic drainage areas from a week to two weeks after radical excision of the primary growth, as recommended by Pack and Livingston,¹ represents a real forward step in the treatment of this condition. The demonstration of naevocarcinoma cells within the dissected lymph glands and the improved results as reported by these authors is proof of the efficacy of this procedure.

Eleven patients had local or radical excision or multiple excision followed by regional lymph node dissection. These patients, however, would not fit in with the

procedure as outlined by Pack,¹ in that none of these dissections were done until there was clinical evidence of spread to the lymph nodes. Only one patient had the secondary operation in a month's interval and this case had both local and glandular spread at the time of the second operation. The average interval between the excision of the tumor and the dissection of the lymphatic drainage area was more than one year for the four cases who survived. It is immediately suggested that in these particular cases, the growth was slow and the metastatic spread delayed.

Several of these patients received radiation therapy. This therapy was applied to distant metastases in cases in which surgery could no longer be considered of palliative or curative value. As a rule these lesions are much more radioresistant than the usual squamous cell carcinoma. Irradiation of a melanoma when it can be surgically removed only adds to the difficulties of surgery if decided upon later.

SUMMARY

Melanoma is defined as a malignant tumor of pigment producing cells. Its relationship to the benign naevus is discussed. The microscopic appearance and different theories as to origin of melanotic cells are outlined. Racial and hereditary characteristics are discussed.

Thirty-two cases of melanoma entered at the Brooklyn Cancer Institute in the five-year interval between 1936 and 1942 are reviewed and results summarized. From these records it appears that this tumor most frequently metastasizes first to the regional lymph nodes. This spread may occur after an interval of from three months to six years. The most frequent site of distant metastasis was found to be lung, liver and bone. The latent period before the development of distant metastases was two years eight months.

The best results were obtained in this series by radical local removal. The authors, however, agree that this should be followed whenever possible by regional

lymph node dissection as recommended by Pack.¹ Radiation therapy is discouraged except for treatment from a palliative angle.

5. RIBBERT, H. Ueber das Melanosarkom. *Ziegler Beitr. z. path. Anat.*, 21: 471-498, 1897.
6. MASSON, P. Les naevi pigmentaires, tumeurs nerveuses. *Ann. d'anat. Path.*, 3: 417-453, 657-696, 1926.

STATISTICAL TABLE OF ALL CASES REVIEWED—COMPARING METHOD OF TREATMENT
AS AGAINST SURVIVAL

Method of Treatment	Number of Cases	Living			Expired		
		Alive	Survival Following Clinical Onset of Activity	Survival Following Surgical Intervention	Dead	Duration of Life Following Clinical Onset of Activity	Duration of Life Following Surgical Intervention
1. Single local excision.....	6	0	.....	.....	6	2 yrs. 2 mos.	2 yrs.
2. Multiple local procedures.....	7	0	.....	.....	5	2 yrs. 6 mos.	1 yr. 5 mos.
3. Radical excision C.....	11	8	5 yrs.	3 yrs. 6 mos.	3	4 yrs.	3 yr. 6 mos.
4. Local excision or radical excision delayed regional lymph node dissection	10	4	3 yrs.	2 yrs. 6 mos.	6	2 yrs. 9 mos.	2 yr. 6 mos.

REFERENCES

1. PACK, GEORGE T. and LIVINGSTON, EDWARD M. *Treatment of Cancer and Allied Diseases*. New York, 1940. Paul B. Hoeber, Inc.
2. BLOCK, B. Chemische Untersuchungen uber das spezifische pigment bildende Ferment der Haut, die Dopaoxydase. *Ztschr. f. physiol. Chem.*, 98: 226-254, 1916-1917.
3. BOYD, WILLIAM. *Textbook of Pathology*, 1938. Lea and Febiger.
4. EWING, JAMES. *Neoplastic Diseases*. 4th ed., Philadelphia, 1940, W. J. Saunders Co.
7. BAXTER, H. Malignant melanoma in colored races. *Canad. M. A. J.*, 41: 350-354, 1939.
8. CHOLNOKY, TIBOR DE. Melanoma. *Ann. Surg.*, 113: 392-410, 1941.
9. PARKES WEBER, F., SCHWARTZ, E. and HELLEN-SCHMIED, R. Spontaneous inoculation of melano-tic sarcoma from mother to fetus. *Brit. M. J.*, 11: 537-538, 1930.
10. TAUSSIG, L. R. and TORREY, F. A. Malignant melanoma: a statistical and pathological review of thirty-five cases. *Calif. & West. Med.*, 52: 15-18, 1940.



BILIARY TRACT SURGERY

SURVEY IN SALT LAKE CITY HOSPITALS 1930 TO 1940 INCLUSIVE

KENNETH B. CASTLETON, M.D.

Instructor in Surgery, University of Utah Medical School

SALT LAKE CITY, UTAH

THIS paper represents a survey of biliary tract surgery in the four general hospitals of Salt Lake City for the period extending from January 1, 1938, to December 31, 1940, inclusive. This survey was conceived with the idea that such a study might prove of interest and value since it differs from most studies of biliary tract surgery in several important particulars. Most such studies come from large clinics, hospitals or groups in which the work is done by a few highly trained

TABLE I

Total number of patients.....	401
Total number of operations.....	411
Total number of deaths.....	29
Death rate per patient.....	7.2%
Death rate per operation.....	7.05%
Number of surgeons.....	77

surgeons under ideal or nearly ideal and uniform conditions. This study on the other hand represents the work of a comparatively large group of surgeons (seventy-seven) of variable training and experience, no doubt using variable technics not only in the operation itself but also in the preoperative preparation and postoperative care. It represents 411 operations on 401 patients. The great majority of these patients are private cases although in the Salt Lake General Hospital all were charity cases and in the other hospitals there was a small percentage of charity patients in each.

This study is not intended to reflect on or to give undue credit to the skill, judgment or surgical ability of these men and the hospitals. It was undertaken as a purely scientific study with their co-operation and support and for this I am indebted to them.

Table I represents the types of operation in this study, the number of each and their

attendant mortality. It will be seen that the entire group represents a mortality rate of 7.2 per cent per patient and 7.05 per cent per operation. In contrast to this Lahey¹ reports 2,346 cases with a mortality rate of 3.8 per cent; Walters^{2,3} 1.8 per cent mortality in 930 cases (1938); 2.8 per cent (1939) in 1,179 patients; Goldman⁴ 2.5 per cent (435 cases), etc. (Table iv.)

Age. The ages of the patients in this group varied from nineteen to eighty years and the average for the entire group was 48.2 years. There was just one patient under the age of twenty (19) and twenty others under the age of thirty years. None of the group under the age of thirty died, and of these twenty-one patients twelve had gallstones and of these one had acute cholecystitis, the others having chronic cholecystitis except one which had acute cholecystitis without stones. Sixteen patients had cholecystostomy done and only five had cholecystectomies.

Sex. There were eighty-seven males and 314 females or a ratio of 21 per cent males and 79 per cent females. This is in line with other published reports although many series give a higher proportion of males than is present in this series. Walters reports the ratio of females to males is about 2½ or 3 to 1.

Incidence of Stones. Of the 411 patients operated upon 288 were found to have stones either in the gallbladder or the ducts or both; 113 did not have stones. The proportion of stoneless cases in this series is high compared with most reported series. In contrast to these figures of 70 per cent of cases having stones and 30 per cent of stoneless cases, Lahey¹ reports 2,346 cases of which 95 per cent had stones in the gall-

bladder or the ducts, Walters² reports approximately 90 per cent with stones and 10 per cent without stones, and in Whipple's⁵ series the proportion is 80 per cent and 20 per cent etc. (Table VI.)

Pathology. Eighty-nine patients of this series had acute cholecystitis, an incidence of 21.6 per cent. This compares with an

13.4 per cent. There were three cases of carcinoma of the gallbladder and in two of these a cholecystectomy was done and in one a cholecystostomy. There were 313 cases of chronic and subacute cholecystitis, an incidence of 76.1 per cent. There were two cases of papillomas of the gallbladder and one case of carcinoma of the liver. (Case in which cholecystgastrostomy was done; patient died.)

TABLE II

Type of Operations	Number	Percentage	Deaths	Mortality, Per Cent
Cholecystectomies	301	73.2	12	3.98
Cholecystostomies	61	14.8	9	14.7
Cholecystectomies and choledochostomy	33	8.0	4	12.1
Cholecystostomies and choledochostomy	5	1.2	1	20
Plastic operation on common duct	3	0.7	1	33 1/3
Choledochostomies	2	.4	1	50
Cholecystoduodenostomies	1	.2	0	0
Cholecystgastrostomies	1	.2	1	100
Exploration and lysis of adhesions	4	.9	0	
	411		29	

incidence of 14.3 per cent in Heyd's series⁶ 5.9 per cent in Walter's^{2,3} series of 1939 and 5.4 per cent in 1940; 12.2 per cent in Goldman and Bell's⁴ series and 6.6 per cent in that of Whipple's.⁴ Of these eighty-nine cases thirty-eight had clinical evidence of acute inflammation of the gallbladder as evidenced by fever and leucocytosis as well as a pathologic diagnosis of acute cholecystitis. Twenty-eight had a pathological diagnosis of acute cholecystitis but no fever or leucocytosis. Twenty-three had clinical evidence of acute inflammation of the organ with fever and leucocytosis but there was no tissue removed at operation from which a pathologic diagnosis could be obtained. This latter group in most cases had an operative note to the effect that there was acute inflammation, empyema, perforation, etc. Of these eighty-nine patients, twelve died, a mortality rate of

TABLE III

Number of patients having stones	288
Number of patients not having stones	113
	401
Average age	48.2
Sex	
Male	87
Female	314
	401
Acute Cholecystitis	
Diagnosed clinically but no pathological specimen	23
Diagnosed pathologically	28
Diagnosed pathologically and clinically	38
	89

Type of Operation. There were 301 cholecystectomies in the 411 operations, an incidence of 73.2 per cent, sixty-one cholecystostomies (14.8 per cent), thirty-three cholecystectomies with choledochostomy (8.0 per cent), five cholecystostomies with choledochostomy (1.2 per cent), choledochostomy alone in two or .4 per cent, three plastic operations on the common duct (0.7 per cent), one cholecystoduodenostomy, one cholecystgastrostomy, and four cases of exploration with lysis of adhesions around the gallbladder. The incidence of cholecystectomy and cholecystostomy in this series corresponds quite closely with the incidence of these procedures in other series. In the listing the first figure indicates the percentage of cholecystectomy and in the second the incidence of cholecystostomy: Heyd's⁶ 61 and 1 per cent; Goldman and Bell's⁴ 78 and 13.7 per cent; Walter's^{2,3} 79 and 5 per cent; Bachhuber's⁷ 71.2 and 1.6 per cent; Evans and Evert's⁸ 11.9 per cent; Haggard et al.⁹ 78 and 10.3 per cent;

Whipple's⁵ 62.7 and 3.4 per cent; Allen's¹⁰ 56 and 6.2 per cent, etc. (Table iv.)

Common Duct Exploration. The indications for exploration of the common duct have been much discussed in recent years

the pancreas; (6) presence of small stones in the gallbladder or cystic duct. Lahey¹⁴ gives the following indications: (1) Jaundice past or present; (2) thickened or contracted gallbladder; (3) dilated duct; (4)

TABLE IV

Author	Ectomy		Ostomy		C.D. Explor.		All Cases	
	No.	Mortality, Per Cent	No.	Mortality, Per Cent	No.	Mortality, Per Cent	No	Mortality, Per Cent
Cheever ¹⁶	260	0 8			166	4 8	452	4 1
Bachhuber ⁷	566	6 4	67	11 9	64	20 3	630	8 41 (Excludes secondary ops. and tumors)
Grey Turner ¹⁵	790	3 55	(Ect. and ostomy)		220	13 18	1040	5 86
Haggard and Kirtley ⁹	749	6 6	(Ect. and ostomy)		86	10 4	841	7 3
Boyd ¹⁷	412	11 2	39	30	43	11 5	1018	10 5
Whipple ⁵	527	1 1	29	6 1	162	26 5	840	
Allen ¹⁰	1183	2 45	130	12 3	775	4 25	2088	3 73 (Excludes cancer and bile duct injury)
Heyd ⁶	2438	3 61	43	30 24	296	16 5	3986	7 7
Heyd ¹³	428	7 47	45	28 8	98	14 2		
Lahey ¹							2346	3 8
Glenn ¹¹					112	12 5		
Walters ²							930	1 8
Walters ³	1018	1 8	65	10 8	364	3		
Goldman ⁴	343	1 7	6	0	86	5 8		(No plastic cases)
This series	301	3 98	61	14 7	40	15	411	7 05

and there is some disagreement among various writers regarding them. For example Glenn¹¹ gives the following indications: (1) Palpable stones; (2) history of progressive jaundice or repeated attacks of jaundice; (3) a dilated common duct. If the common duct is indurated with acute or subacute inflammation of the gallbladder with only mild jaundice (an icteric index of 30 or less) the common duct is not opened. Crile (quoted by Eiss¹²) gives the following indications: (1) History of chills, pain and fever; (2) dilatation of the common duct; (3) jaundice, not otherwise accounted for; (4) palpable stones. Cutler and Zollinger (quoted by Heyd¹³) give the following indications: (1) Suggestion of stones on palpation; (2) dilated or thickened common duct; (3) a contracted gallbladder; (4) a dilated cystic duct; (5) thickened head of

palpable stones; (5) thickened head of pancreas; (6) character of bile, if murky or deeply clouded the common duct should be opened. Walters³ says that the common duct should be opened if: (1) The duct is enlarged; (2) if there is a palpable stone; (3) if there is a history of jaundice, chills and fever; (4) cases of recurrent intractable symptoms following biliary surgery.

Although these indications vary somewhat, they agree fairly well on three indications, namely, (1) the presence of palpable stones, (2) a dilated common duct, (3) a history of jaundice.

The operative notes and histories in this series of cases were carefully examined in an effort to determine how many of them should have had the common duct explored. Incompleteness of hospital records made this impossible with any degree of

accuracy. In very few operative reports was anything said about the size or induration of the common duct, or of the size of the stones in the gallbladder. The records on jaundice, however, were probably fairly

total of forty-three who had their common duct opened and excluding three cases who had plastic procedures on the common duct, this leaves only forty cases, an incidence of 9.7 per cent in which the

TABLE V

Author	No. of Cases	Ect. Alone		Ost. Alone		Ect. and Doch.		Ost. and Doch.		Doch. Alone		Plastic, Etc.	
		No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Heyd	3,986	2,438	61	43	1	238	5.9	16	0.4	37	0.4	5	0.1
Goldman and Bell	435	343	78	6	13.7	(86 with ect. or ost.)			19.7				
Walters	1,289	1,014	79	65	5	(327 C.D. opened)			25.4				
						(364 oper. on C.D.)							
Bachhuber	630	499	72.2	67	10.6	(64 cases C.D. opened)			10.1				
Evans and Everts			86		11.9	9.4—C.D. opened							
Haggard, etc	841	662	78	87	10.3	(C.D. opened in 86)			10.29				
Whipple	840	527	62.7	29	3.4	(162 had C.D. opened)			19				
Allen	2,088	1,183	56	130	6.2	775	37						

accurate since most histories and physical examinations had a statement regarding the presence or absence of jaundice, past or present. A study, therefore, was made using a history of jaundice as the only criterion, to see in how many of these cases the common duct was explored, also to determine in how many of these latter cases stones were found, and in how many cases there was jaundice either at the time of operation or in the past and to see how frequently the common duct was explored as compared with other series. It was found that of the 411 cases, eighty-nine gave a definite history of jaundice at some time and of these twenty had their common duct explored. Nineteen gave a history of slight or doubtful jaundice past or present and of these five had their common duct explored. There were twenty-five others who had definite jaundice at the time of operation or slight or doubtful jaundice, but no history of it in the past and of these, eighteen had their common duct opened. This makes a

common duct was opened. This compares with Goldman's⁴ series 19.8 per cent, Lahey's¹ 45 per cent, Walter's^{2,3} 22, 19 and 24 per cent, Grey Turner¹⁵ 21 per cent, Whipple's⁵ 19 per cent and Allen's¹⁰ 37 per cent incidence of choledochostomy. That absence of jaundice, past or present, does not indicate absence of stones in the common duct is shown by Lahey¹⁴ who found that 40 per cent of those cases in which stones were found in the common duct had no history of jaundice.

It is of interest further to study the mortality rate of the common duct explorations in this series and to compare them with others. There were forty cases in which the common duct was explored. The mortality for the group was 15 per cent. This series is small but the rate is high when compared with those of some writers. Cheever,¹⁶ for example, reported 166 cases with a mortality of 4.8 per cent, Allen¹⁰ 775 cases with 4.25 per cent mortality, Walters² 364 cases with 3 per cent mortality and

Goldman⁴ eighty-six cases with 5.8 per cent. On the other hand there are many who report a higher mortality than is found in this series. Bachhuber⁷ (L. A. General Hosp.) reports sixty-four cases with 20.3

often as should have been done. There may be and undoubtedly are many surgeons who do not share Lahey's opinion that the common duct should be opened in 40 to 50 per cent of the cases. Certainly it has been

TABLE VI

	Percentage of Cases with C.D. Opened	C D Explorations and Stones Found in Common Duct
Lahey	45%	18% of total cases
Glenn	112 of 907—12.1%	60 of 122—59.8% of cases of C.D. opened
Heyd	392 of 3,986—9%	No. of stones (?) doesn't say
Walters	186 of 850 (1937)—22%	Stones in 88% of 186—47.3%
	174 of 930 (1938)—19%	Stones in 78% of 174—47.8%
	254 of 1,079 (1940)—24%	Stones in 149—58%
Goldman	86 of 4,443—19.8%	Stones in 10.9%
Heyd	7.7%	Stones in 69% or 28% of C.D. opened
Evans and Everts	9.4%	
Grey Turner	220 of 1,040—21%	
Haggard, etc	86 of 841—10.2%	
Whipple	162 of 840—19%	
Allen	775 of 2088—37%	

per cent mortality, Whipple⁵ (Presbyterian Hospital) 162 cases with 26.5 per cent mortality, Heyd⁶ 296 and 16.5 per cent, etc. Walters reports that in his experience a choledocholithotomy can be done with little more risk than a primary cholecystectomy. Lahey¹⁴ states that in experienced hands exploration of the ducts does not add to the risk and diminishes mortality and morbidity. He explores the ducts in 40 to 50 per cent of his cases and finds stones in 16 to 20 per cent of the total or nearly half of those in which he opens the duct. He also reports that about 4 per cent of cases have stones in the common duct but not in the gallbladder and Heyd⁶ found the same situation in 6 per cent. In the hands of operators in this series, exploration of the common duct added considerably to the operative mortality.

Comment. There may be some disagreement concerning the indications for exploration of the common duct. I am sure, ever, that all will agree that jaundice, past or present, constitutes one indication. Using this one indication as a criterion, it is obvious that in this series common duct exploration was not carried out nearly as

the experience of many surgeons of large experience that common duct exploration has been necessary in much smaller percentage of cases and these men claim that the incidence of bad results such as the necessity of secondary operation for stones missed is low.

The advisability of such a high rate of common duct exploration also seems somewhat questionable in view of Goldman's findings that injury to the common duct is apparently increasing. In spite of all this it appears certain that the common duct was opened in too small a percentage of cases in this series (less than 10 per cent). On the other hand the high mortality of this procedure in this series would seem partially to justify this tendency to shy away from the common duct by many surgeons. In considering these facts and figures one cannot help but arrive at the conclusion that common duct surgery (and we must necessarily include gallbladder surgery in general since one cannot know beforehand which cases will need the common duct explored) should be done only by well trained experienced surgeons.

SUMMARY

This paper reports on a series of surgical cases involving the biliary tract operated upon in the four general hospitals of Salt Lake City in 1940.

There were a total of 411 operations of 401 patients carried out by seventy-seven different surgeons.

The mortality rate for the group was rather high, being 7.2 per cent per patient and 7.05 per cent per operation.

The common duct was explored in only 9.7 per cent of cases (excluding three cases of plastic operation of the duct). This is low according to present indications. The mortality rate for this group, however, was quite high (15 per cent).

REFERENCES

1. LAHEY, FRANK H. *Surg. Clin. North America*, 19: 597-615, 1939.
2. WALTERS, W., GRAY, H. K. and PRIESTLEY, J. T. *Proc. Staff Meet., Mayo Clin.*, 16: 681, 1941.
3. WALTERS, W. *Surg. Clin. North America*, 19: 845, 1939.
4. GOLDMAN, LEON and BELL, H. G. Surgical management of disease of the gall bladder as correlated with newer physiologic concepts. *J. A. M. A.*, 117: 1582-1585, 1941.
5. WHIPPLE, A. O. *Nelson's Loose Leaf Surgery*, N. Y.
6. HEYD, C. D. *Mississippi Doctor*, 18: 117-123, 1940.
7. BACHHUBER, CARL A. *Medical Times*, 68: 3-7, 1940.
8. EVANS, C. A. and EVERTS, E. L. *Wisconsin. M. J.* 38: 529-532, July, 1939.
9. HAGGARD, W. D. and KIRTLEY, J. A., JR. *J. Tennessee Med. Ass.*, 32: 126-132, 1939.
10. ALLEN, W. A. *Kentucky M. J.*, 38: 588-593, 1940.
11. GLENN, FRANK. *Ann. Surg.*, 112: 64-79, 1940.
12. EISS, S. *Internat. Abstr. Surg.*, 72: 521, 1941.
13. HEYD, C. G. *Am. Surg.*, 111: 820, 1940.
14. LAHEY, F. H. *Surg., Gynec. & Obst.*, 67: 698-699, 1938.
15. TURNER, G. GREY. *Brit. M. J.*, 1: 464-465, 521-522, 630-631, 1939.
16. CHEEVER, DAVID. *New England J. Med.*, 219: 731-735, Nov. 10, 1938.
17. BOYD, P. L. *New England J. Med.*, 218: 1045, 1938.



BLOOD VESSEL SUTURE

ITS USE INSTEAD OF THE LIGATURE IN WAR SURGERY

CHARLES GOODMAN, M.D.

NEW YORK, NEW YORK

MATAS must be accredited with having first stressed the importance of the preservation and careful ap-

France) and assigned to a Casualty Clearing Station in the Ypres district, I found that ligature was the accepted method for

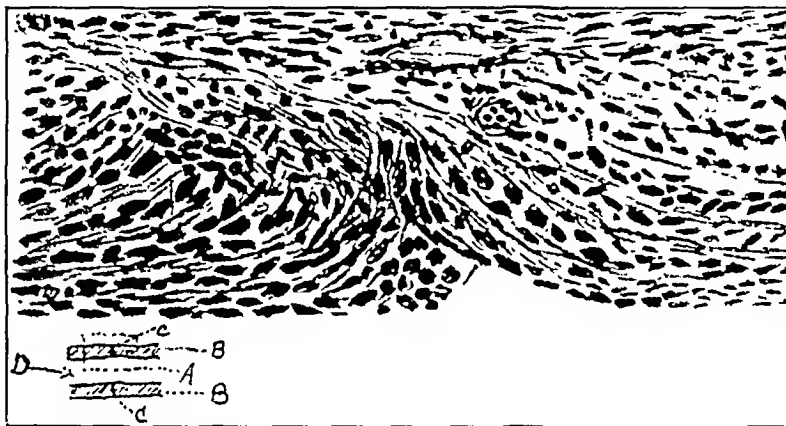


FIG. 1. End-to-end suture of carotids. Dog No. 108. Surg. Path. No. 3846. Operation January 20, 1916. Specimen removed February 9, 1916. Cicatricial tissue firmly unites one vessel end to that of the other. One extremity is slightly everted and the other is implanted upon it. The recess is so obliterated by connective tissue that the intimal lining is completely regenerated. The suture line is hardly discernible on account of the merging of the cicatrix with the sutured ends. Smooth muscle cells as demonstrated in a Van Gieson stain infiltrate the cicatrix. (Goodman, Charles. *Ann. Surg.*, July, 1917.)

proximation of the edges of the endothelium during vascular repair. This was emphasized in his description of aneurismorrhaphy in 1888. Fifteen years later Carrel stimulated renewed interest in vascular surgery by his brilliant animal research which led to the successful development of blood transfusion and the simplified technic of blood vessel suture.

In 1913, a symposium on the subject of blood vessel suture was held during the session of the International Medical Congress in London. At that session I had reported my technic for arteriovenous anastomosis in fifteen consecutive cases.

In November, 1917, while overseas with the Presbyterian Hospital Unit (B.E.F.

the treatment of blood vessel injuries. It was recognized that ligature of the popliteal or posterior tibial artery was almost invariably followed by gangrene, but apparently no one in the British Service had attempted suture in the treatment of such wounds at the Casualty Clearing Station. At that time I used the Carrel suture in five cases on the popliteal vessels. In these cases the restoration of the continuity of the vessels resulted in tibial pulsation, and gangrene was averted. The following is a brief report of two of these cases:

CASE I. On November 10, 1917, Private M. C. K. G., age twenty-eight, was brought in with the hamstring muscles badly lacerated. The popliteal vessels were exposed and the

artery and vein were found lacerated. Bleeding was temporarily controlled by the use of flexible clamps, and a longitudinal opening measuring

in the popliteal artery just below Hunter's canal with loss of an oval segment of the wall of the vessel. The opening was closed by suture

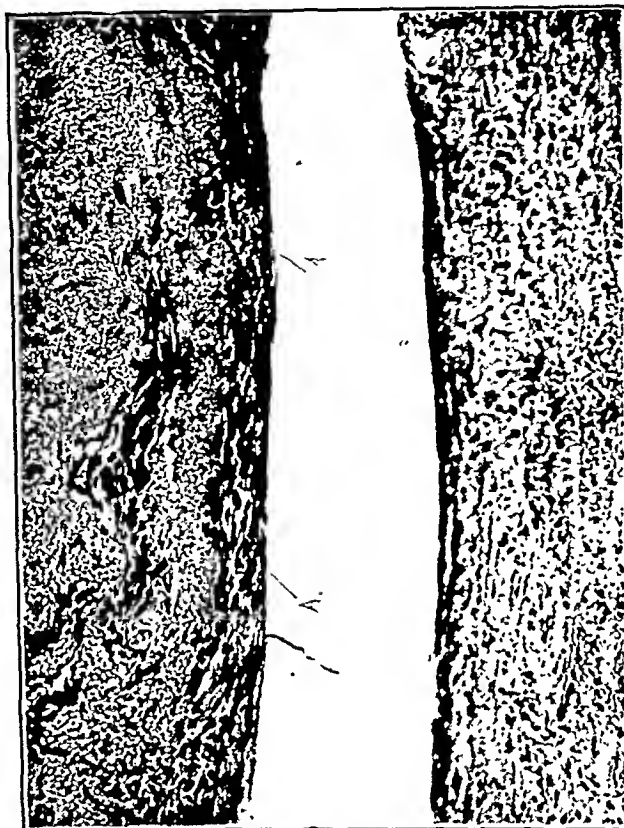


FIG. 2. Microphotograph, mag. 415. Autotransplantation of vein into carotid. Surg. Path. No. 2283. Operation January 3. Specimen removed January 17. Vessel partially occluded by coagulum. Surface of coagulum presents connective tissue cells and apparently no accretion has taken place. Blood coagulum covered by growing fibroblasts also infiltrating coagulum. No further tendency for blood to form a clot in the coagulum which presents a smooth surface as shown here. (Goodman, Charles. *Ann. Surg.*, July, 1917.)

5 mm. in the wall of each of these vessels was repaired with a continuous silk suture. A flap of muscle was reflected over the line of suture for protection, and a Carrel-Dakin dressing applied. Forty-eight hours after the operation the foot was warm, the dorsalis pedis artery perceptible and pulsations normal. Eight days later the dorsalis pedis and posterior tibial arteries were pulsating vigorously; his temperature and pulse were normal and the soldier was transferred to the Base Hospital.

CASE II. On November 25, 1917, a private, age twenty-one, was admitted with a through-and-through shell wound of the left thigh. A large oval opening $1\frac{1}{4}$ cm. in length was found

and the caliber of the lumen was reduced to about one-half its normal size. A branch of the femoral vein was ligated. Following débridement of the wound, the suture line in the vessel was covered with a flap of fascia lata to protect it from erosion by the Carrel-Dakin tubes. The circulation of the limb was satisfactorily restored and he was transferred to the Base Hospital. Seventeen days later the soldier wrote me that he had no pain and was making excellent progress.

Subsequently, a few French surgeons employed early suture of blood vessel injuries in war wounds.

In reviewing the treatment of blood vessel injuries at the ambulance Chirurgicale under the command of Proust, the

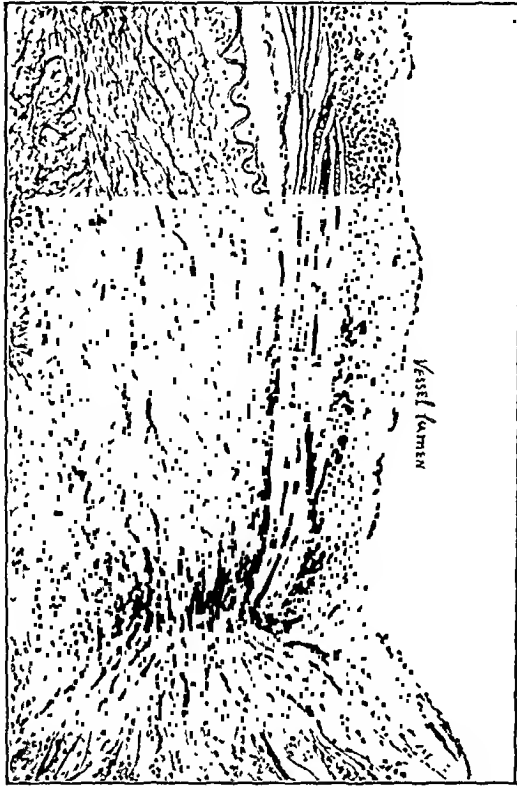


FIG. 3. End-to-end suture of carotid. Dog. no. 27. Surg. Path. No. 3729. Operation, November 13, 1915. Specimen removed November 22, 1915. Sutured ends separated by $\frac{3}{2}$ mm. of connective tissue on one side; on the other side by 2 mm. This connective tissue at some points is dense; at other points it is loosely constructed. The intima regenerates everywhere. At one point, one of the sutures lies within the vessel lumen, and is completely covered by connective tissue with an endothelial surface. Where there was wide separation of the vessel ends, there is a considerable mass of relatively loose connective tissue on the surface which is covered with intima. In the depths the repaired vessel wall is dense and suggests osteoid structures. In the depths of the suture line at another point, very definite osteoid structure exists. There is a distinct dilatation of the lumen present at the site of the suture line. (Goodman, Charles. *Ann. Surg.*, July, 1917.)

French Surgeon, Maurier, notes that he successfully sutured the popliteal artery in two cases. Learmonth, the Edinburgh surgeon, stated in his demonstration, that suture is the ideal method of repairing wounds of blood vessels and restoring their

continuity. He adds "hitherto it has had a limited application in military surgery."

During the first World War a number of surgeons of the Central Powers stressed the importance of early suture of blood vessels in the treatment of war wounds. Before the end of the war Von Haberer had reported 200 cases of blood vessel injuries treated by this method, with only one failure. Recently, he again advocated suture as the best method for repair of blood vessel injuries.

On the basis of experiences in the first World War and in civilian practice, I want to emphasize the fact that suture of the blood vessels should have a wider application in war surgery. Despite extensive lacerations resulting from the missiles of war, repair of the arteries of the extremities can be advantageously undertaken in the advanced operating centers. Most of the wounded arrive at such centers within twenty-four hours—a time most favorable for repair of the damaged blood vessels. The wounds may be contaminated but the infection has not yet become invasive. Elaborate instruments are not required for blood vessel suture. The simple equipment can easily be kept in readiness at the advanced operating centers. Fine straight cambric needles (Kirby 16) threaded with fine silk are employed; flexible blood vessel clamps are best for the temporary control of the injured vessels but other devices may be used. The threaded needles are sterilized in mineral oil. These should be kept on hand ready for immediate use. A needle holder is not an absolute necessity. I have adopted an epilating forceps as a convenient instrument for guiding the needle when working in a narrow field. The threaded silk sutures are wound loosely about a small square of cardboard to keep them from becoming snarled.

In the treatment of war wounds with injured vessels, débridement with the removal of all damaged and necrotic tissues should be completed before the repair of the injured vessels is undertaken. Where the vessel is deeply situated, ligation of one

or two of its branches will render the vessel more accessible. The injured vessel is elevated to the surface on two pieces of tape

Should the adventitia be included in the suture it may invite thrombosis. The segment between the temporary clamps or



FIG. 4. Microphotograph, mag. 200. Auto-transplantation of jugular to carotid, two weeks. Dog No. 201. Surg. Path. No. 2340. Specimen removed January 31, 1913. Walls of the vessels are separated by about one millimeter. The interval is filled in by dense connective tissue. Scar tissue is somewhat irregular but not covered by fibrin, except at one point. A uniform and regular layer of cells covers the cicatricial scar tissue. (Goodman, Charles. *Ann. Surg.*, July, 1917.)



FIG. 5. Microphotograph, mag. 415. Auto-transplantation of jugular to carotid; two weeks. Dog No. 201. Surg. Path. No. 2340. Operation January 31, 1913. Walls of the vessels are separated by about 1 millimeter. The interval is filled in by dense connective tissue. Scar tissue is somewhat irregular but not covered by fibrin except at one point. A uniform and regular layer of cells covers the cicatricial scar tissue. (Goodman, Charles. *Ann. Surg.*, July 1917.)

and these may be used for the control of the circulation above and below the laceration. If flexible blood vessel clamps are not at hand, rubber bands or smooth forceps without teeth tied with a ligature may be substituted. A small rubber bulb or piston syringe with saline or Ringer's solution is used to wash away the clot presented at the opening. The adventitia or outer coat of the vessel is then trimmed away about the edges of the wound with the aid of small forceps and scissors. Adventitia contains considerable thrombokinase or ferment.

tape ligatures is perfused thoroughly with saline or Ringer's solution followed by a few drops of vaseline or mineral oil. The mineral oil keeps the vessel from drying. The rent in the vessel is then closed with a simple overhand suture. With the suture completed, the temporary compression clamps or tapes are removed and gentle pressure applied with a pledget of gauze dipped in mineral oil. Slight oozing may prevail for a few seconds. Should there be a spurt of blood because of the unevenness of the suture, an additional suture introduced

and tied at the point of hemorrhage will effectively control the spurt. The walling off of the operating field with pieces of

guide sutures will usually be followed by relaxation. This overcomes the tendency to retraction of the segments, and the circular



FIG. 6. Microphotograph, mag. 100. Arteriovenous anastomosis (human vessels). Surg. Path. No. 3550. The artery in close apposition with vein, especially the adventitia and media. Mass of connective tissue which has grown beneath the intima reinforces the junction. In the section at points the endothelium is intact. A thin layer of fibrin with a few round cells in it is in the venous portion of the section. (Goodman, Charles. *Ann. Surg.*, July, 1917.)

black silk or other material will maintain a field free from contamination and will render the fine silk sutures discernible, and simplify the procedure. Where a large artery has been completely severed, the ends may be found curled up and retracted. After the wound is débrided, the ends of the severed arteries are exposed and the adventitia overhanging the severed ends of the vessel is removed readily by pulling the adventitia over the end and snipping it off with one stroke of the scissors. This leaves the media and intima exposed for the suture. Three guide sutures are introduced, uniting the two severed ends. I have observed during my personal experience, that approximation of the severed ends by three



FIG. 7. Homotransplantation of femoral vein to jugular vein. Surg. Path. No. 2477. Operation April 11, 1913. Specimen removed April 18, 1913. Shows two valves in transplanted vein, one of which encroaches upon suture line; no thrombosis. (Goodman, Charles. *Ann. Surg.*, July, 1917.)

suture may then be completed without any appreciable difficulty.

The technic of the circular suture is identical with the Connel end-to-end intestinal anastomosis. The only difference observed is that instead of inverting the edges to favor a peritoneal adhesion, in the vascular suture, the edges are slightly everted so that the adhesive properties of the endothelium may be taken advantage of.

In the first World War, most of the wounds requiring blood vessel repair were treated by Dakinization, but with the modern use of sulfanilamide, the post-operative care of these wounds will be greatly simplified and the danger of infection and sepsis minimized. The advantage of suture over ligation is in the restoration of the circulation to the limb, obviating the dangers of gangrene and the tendency to gas gangrene infection. Ligation of the main vessel of an extremity when not followed by gangrene, results almost invariably in neurovascular disturbances of a more or

less serious character. These late complications may be avoided by suture, and the repair likewise does away with the poten-

develop. Thrombosis is prevented by the two important factors in the technic which I have described: (1) bloodless field with



FIG. 8. Arteriovenous anastomosis of femoral vessels removed eighty-three days after operation; male adult, age thirty-five. Surg. Path. No. 3550. (Goodman, Charles. *Ann. Surg.*, July, 1917.)

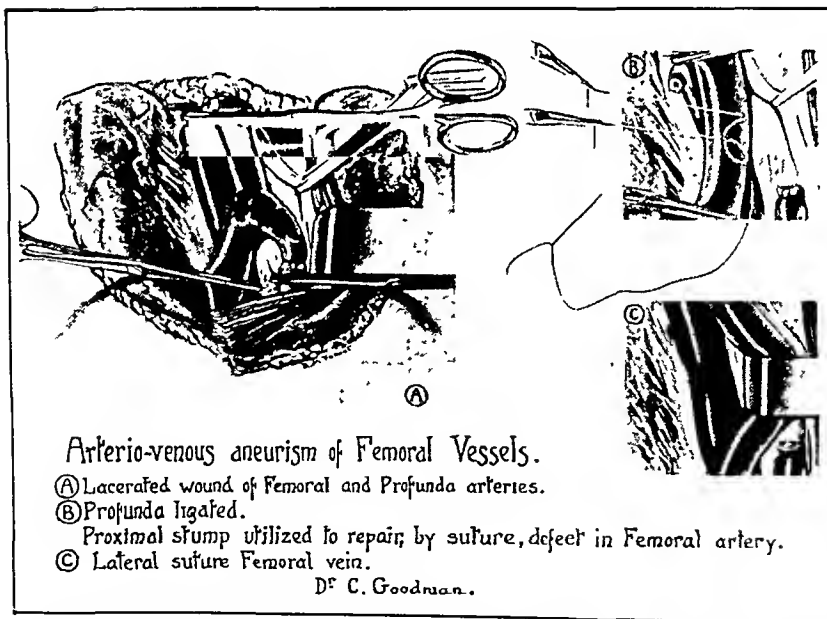


FIG. 9. Arteriovenous aneurysm of femoral vessels. A, lacerated femoral repaired by reflecting stump of profunda and suture; B, lateral opening in femoral vein closed with continuous suture.

tial danger of aneurysmal formation with its cardiovascular complications. If the suture does not prove entirely successful and thrombosis follows, the occlusion takes place so slowly that ample time is afforded for an adequate collateral circulation to

thorough washing away of all the clots from the segment to be repaired; (2) the removal of the adventitia from the edges of the wound. The condition of the soldier more or less exsanguinated demands transfusion rather than the administration of

anticoagulants. Recently, the use of heparin has been advocated for the prevention of thrombosis in blood vessel surgery. In my

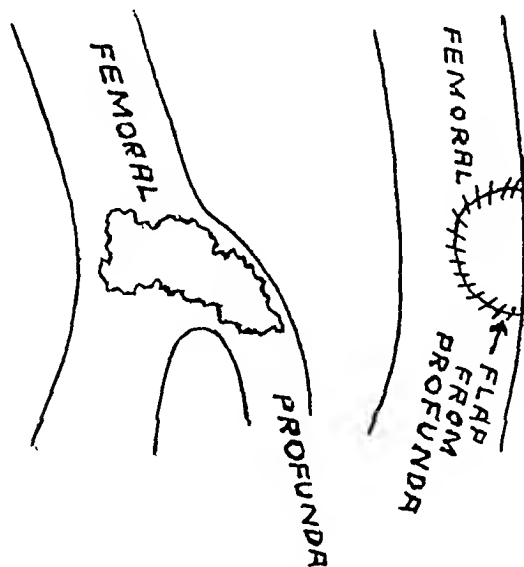


FIG. 10. Diagram of the procedure.

opinion heparin is not of value in the severely wounded requiring blood vessel suture.

When a portion or segment of an artery has been destroyed or completely carried away by the missile so that the severed ends cannot be readily approximated, one may resort to the use of a paraffined Tuffier tube. The tube is introduced into the respective severed ends of the artery. The flanged ends are secured by simple ligature which prevents them from being displaced. When removed at the end of several days, these paraffined tubes may be found partially or completely filled with soft coagulant, but an ample opportunity for the development of the collateral circulation will have been attained.

Under favorable circumstances, a segment of the saphenous vein can be interposed with the aid of a bipolar circular suture. The procedure will be followed by satisfactory and permanent restoration of the continuity of the vessel. In times of total war, civilian casualties as well as casualties in the armed services deserve the advantageous use of the blood vessel suture. What has been emphasized in

regard to blood vessel repair in the advanced operating stations of the army, applies with equal force to the immediate treatment of the injured among the civilian population, as well as in the treatment of industrial accidents.

During the First World War, surgeons of the Central Powers appreciated the advantages of the vascular suture as against the obliterating ligature. Among these the leading advocates were: Bier, von Haberer and Stich.

The statistical results gathered and published in the second edition of *Lehrbuch der Kriegschirurgie* by Carl Franz, are illustrated in the following tables:

Operator	Suture	Ligature	Deaths	Total
Bier.....	74	28	8	102
Brunzel.....	0	8	2	8
Franz.....	15	41	9	56
Fromme.....	3	46	3	49
Graf.....	15	58	15	72
v. Haberer.....	122	50	10	172
Kuttner.....	24	67	1	93
Liek.....	0	25	13	25
Muller.....	0	17	8	17
Mutschenbacher.....	1	67	4	68
Mutschenbacher-Verbely.	No report	No report	3	40
Schwieker.....	2	15	0	17
Knolle.....	6	...	0	6
Zuckerkindl-Glas.....	12	90	34	102
Goldammer.....	26	28	1	54
Total.....	300	540	111	881

DEATHS FOLLOWING LIGATURE

Operator	Deaths	Total
Bier.....	2	16
Franz.....	7	41
Liek.....	13	25
Muller.....	8	17
Brunzel.....	2	8
v. Haberer.....	8	50
Mutschenbacher.....	3	67
Fromme.....	2	46
Subbotisch.....	9	75
Zuckerkindl-Glas.....	33	90
Goldammer.....	1	28
Total.....	88	463
Mortality.....	14.7%	

DEATHS FOLLOWING SUTURE

Operator	Deaths	Total
Bier		30
Franz	3	19
v. Haberer	2	122
Kuttner	1	24
Fromme	1	3
Knolle		6
Hotz		12
Subbotisch	3	30
Zuekerkandl-Glas	1	12
Goldammer		26
Total	11	284

Mortality following suture 3.8%

COMPARATIVE STATISTICS OF GANGRENE FOLLOWING LIGATURE AND SUTURE

Operator	Liga- ture and Suture	Liga- ture	Suture	Gan- grene Fol- lowing Liga- ture	Gan- rene Fol- lowing Su- ture	Gan- grene Total
Bier	102	28	74	1		1
Franz	56	41	15	7	2	9
Goldammer	54	26	28	5		5
Graf	72	58	15	2		2
v. Haberer	172	50	122			
Kuttner	93	67	24		1	1
Liek	25	25		11		11
Mutschenbacher	68	67	1	2	1	3
Schwieker	17	15	2	1	1	2
Zuekerkandl	102	90	12	23	4	27
Fromme	49	46	3	1		1
Total	810	513 63 %	296 36 6 %	53 10 5 %	9 3 %	62 7 7 %

According to these statistics, gangrene followed ligatures in $10\frac{1}{2}$ per cent while gangrene was observed in but 3 per cent of the cases following suture.

CONCLUSIONS

The blood vessel suture, in place of ligature, undertaken in the advanced operating centers does not entail great difficulties and should be taken advantage of more frequently by our army surgeons. Experiences gathered indicate that the danger of

secondary hemorrhage following suture is a negligible one. The restoration of the circulation in a damaged vessel obviates the danger of gas gangrene. The neuro-vascular disturbances frequently observed following the obliterating ligature are avoided by the restoration of the circulation following blood vessel suture.

The simplified technic of blood vessel suture outlined and perfected by Carrel and taken advantage of in hundreds of cases by the surgeons of the Central Powers during the First World War, have been followed by most satisfactory and brilliant results.

Ample observations of vascular sutures performed in animals as well as in human beings confirm the perfect healing of the line of suture despite the presence of a more or less scar line. The illustrations appended demonstrate clearly how perfectly the intima is reproduced by prompt endothelial proliferation.

REFERENCES

1. MATAS. Surgery of the Vascular System. Keen's Surgery, vol. V, 1909 and Vol. VII, 1921.
2. GUTHRIE, C. C. Blood Vessel Surgery and its Applications. New York, 1912. Longman, Green & Co.
3. CARREL. Surgery of the Blood Vessels. *Johns Hopkins Hosp. Bull.*, Jan., 1907.
4. Abstracts of War Surgery. St. Louis, 1918. C. V. Mosby & Co.
5. GOODMAN. A histological study of the circular suture of blood vessels. *Ann. Surg.*, vol. 65, July, 1917.
6. GOODMAN. Suture of blood vessel injuries from projectiles of war. *Surg., Gynec. & Obst.*, Nov., 1918.
7. GOODMAN. Experiments outlining the limitation of operations on the abdominal aorta. *J. Exper. Med.*, vol. 27, May, 1918.
8. GOODMAN. Surgery of the heart, blood vessels, etc. *Internat. Surg. Congress, Paris*, July, 1920.
9. Transactions of the V. Congress of the International Society of Surgery, Paris, July, 1920.
10. SENCERT. Les Blessures des Vaisseaux. Univ. of London Press, Ltd., 1918.
11. TUFFIER. L'intubation arterielle. *Bull. Acad. Med.*, Oct. 19, 1915.
12. FRANZ. Lehrbuch der Kriegschirurgie. 2nd ed. Berlin, 1936. Julius Springer.



THE FALLACY OF PERITONEAL DRAINAGE

G. W. COTTIS, M.D.

Chief of Surgical Staff, Jamestown General Hospital

JAMESTOWN, NEW YORK

DURING the first two years of the first World War peritonitis from gunshot wounds of the abdomen caused a mortality of close to 100 per cent. Then British Army surgeons began to close the peritoneum without drainage, after carefully suturing all perforations of the hollow viscera. The mortality immediately dropped to about 50 per cent.

In the quarter of a century since this epochal discovery, relatively few American surgeons have profited by it, as is shown by the almost universal mistreatment of appendiceal peritonitis. Our new army is staffed by these same civilian surgeons. Unless they are aware of the deadly results of drainage in general peritonitis, it seems probable that about one-half of our battle casualties involving the abdomen will result in unnecessary deaths. It is the purpose of this paper to prove the truth of this seemingly extreme statement.

In 1905, Yates¹ proved that the peritoneal cavity could not be drained by any method whatsoever. The drains were always walled off within a few hours. His findings have been confirmed by many investigators and refuted by none. Why then do the majority of writers of the subject advocate drainage in peritonitis? If they are at all familiar with the literature, they know that they advise and attempt the impossible except in the case of walled-off abscesses. Their self delusion in the case of diffuse peritonitis is an example of the perpetuation of a fallacy for nearly half a century after the fallacy was exposed.

In 1897, John G. Clark analyzed 1,700 cases of abdominal section at Johns Hopkins Hospital. He concluded that not only is drainage useless in the great majority of cases in which it had been used, but that it was frequently productive of harm.

In 1908 Robert T. Morris,² impressed by Clark's study, reported that in cases of appendicitis with pus and peritonitis he had closed without drainage for about a year with no deaths and no increase of peritonitis.

In 1931, Buchbinder and his associates,³ experimenting on dogs, produced a widespread peritonitis by opening a loop of bowel and leaving it open for twenty-four hours. They then reopened the abdomen and removed the source of infection by closing the bowel. In fifty-three animals so treated thirty-three were closed without drainage, and nineteen or 57.5 per cent died. In the remaining twenty animals two drainage tubes were inserted, one in the upper abdomen and one in the pelvis; all died.

These experimental results are in conformity with surgical experience. For the sake of brevity only a few typical reports will be quoted.

Haggard and Kirtley⁴ quote the experience of Giertz who in patients with purulent appendiceal peritonitis operated upon in the first forty-eight hours, reduced the mortality from 22.2 to 3.5 per cent by primary closure of the peritoneum. These authors also state that the mortality of generalized peritonitis "averages 41.2 in some of our best clinics."

In 1939, Kelly and Watkins⁵ reported that of 171 patients treated by drainage forty-four died, 25.7 per cent, while of nineteen patients treated without drainage only one died and that from postoperative pneumonia.

Convincing evidence is furnished in a remarkable paper of Storck,⁶ who reported forty-six cases of penetrating wounds of the abdomen of which thirty-five were gunshot and eleven were stab wounds. The number

of perforations in the patients who survived averaged 5.44, with a maximum of twenty-five in a single case. These perforations included practically every viscus in the abdomen. The mortality in the cases of stab wounds was 27.2 per cent; and in gunshot cases 40 per cent; and the combined mortality was 37 per cent.

In spite of hemorrhage, shock and gross spillage of intestinal contents from multiple perforations, these figures compare favorably with the mortality of simple perforative appendicitis as reported by some of our best clinics. If one asks how this can be possible, he may find the answer in this sentence from Storck's paper: "Because of the impossibility of draining the peritoneal cavity and because of the danger of intestinal obstruction resulting from the introduction of drains into the peritoneal cavity, the intraperitoneal introduction of drains at the time of operation for penetrating wound of the abdomen is now considered futile." This report should be "must" reading for every military surgeon.

Space does not permit even a summary of the many reports of improved results following the abandonment of the drain, but a few of the writers are: Shipley and Bailey, H. C. Miller, E. P. Hall, Sr., R. D. Kirk, Jr., Stanley Raw, B. Banks-Marchini, J. G. Andrew. It is significant that in a rather extensive review of the literature I have failed to find a single report of a surgeon's return to the use of drainage after he has discontinued its use.

Failure to grasp the significance of all this experience is exemplified by two of many similar recent reports.

In July, 1940, King⁷ in a study of 804 cases of acute appendicitis at the Binghamton City Hospital during the years 1934-1937, states, "... the records show a definite trend toward less frequent drainage in acute appendicitis. Almost without exception, however, drainage was used in peritonitis cases. . . . In all, 277 cases were drained. Of these 216 were cases of peritonitis (only four peritonitis cases were not drained) while sixty-one drained cases

were uncomplicated by peritonitis at the time of operation. . . .

"The cases complicated by diffuse peritonitis had appalling mortalities. In 1929-1930 the mortality in this group was 63.6 per cent, in 1934-1935 it was 33.3 per cent; in 1935-1936, 75 per cent, and in 1936-1937, 85.7 per cent. The four-year average for thirty-two cases was 65.6 per cent, or roughly two deaths out of three cases."

As late as August, 1940, Jackson and Perkins⁸ advocated not only drainage through the wound in all cases in which pus is present, but rubber tube drainage through a stab wound in the flank, and a drain to the pelvis if there is generalized contamination. Although their mortality rate for 100 cases was only 12 per cent, thirty-two of the one hundred developed complications including:

- 6 patients with general peritonitis; all died
- 4 patients with fecal fistula; one was associated with intestinal obstruction and died; one was associated with repeated hemorrhages and died
- 1 patient developed subphrenic abscess and died
- 1 patient developed septicemia and died

None of these complications has occurred in any of our cases of diffuse peritonitis treated by closure without drainage in the past thirteen years with the exception of one death from peritonitis reported below.

In any discussion of peritonitis, confusion results from ambiguous terminology. For the purpose of this paper peritonitis is either localized or diffuse (some authors prefer the term "spreading" for this type). By localized peritonitis is meant a collection of pus surrounded and limited by a definite wall of adhesions. It may be an abscess the size of a walnut or a cavity containing several ounces of purulent fluid. The essential point is that the pus is definitely walled off from the rest of the peritoneal cavity. Whatever its size, it is still an abscess. If the walls of this abscess are lined with intact peritoneum, it may be treated in the same way as diffuse peritonitis without drainage. If the walls are necrotic and the integrity of the peritoneal lining is impaired, or if any part of the wall

is not lined with peritoneum, the treatment does not differ from that of an abscess elsewhere in the body. It must be either loosely packed with gauze or adequately drained.

By diffuse peritonitis is meant an extension of purulent inflammation beyond the immediate source of infection with no definite limiting wall. It may consist of purulent exudate between loops of bowel agglutinated by fresh fibrin deposits, or a pelvis full of pus or an entire abdomen full of infective fluid. The term general peritonitis is properly applied only to the latter condition and it is of rare occurrence. In nearly all cases some part of the peritoneal cavity is kept free from infection by protective adhesions. It is in diffuse peritonitis that drains do the greatest harm.

In untreated peritonitis the cause of death is almost always overwhelming toxemia. After this toxemia has developed operation of any kind is usually futile. For that reason the nondrainage treatment is effective during the first forty-eight hours, after which time the mortality increases rapidly regardless of the form of treatment used. It is in these delayed cases that conservative treatment is indicated, because the defense mechanism of the peritoneum has been overcome by the invading bacteria and general body resistance must be reinforced. We are no longer dealing with a peritoneal battlefield, but a total war involving the entire body. At this stage local treatment is less important than the measures necessary to combat the effects of toxemia, exhaustion, dehydration, disturbance of the acid base balance, and paralytic ileus. No elaboration of these technics is necessary here because they are not germane to the question of drainage. The use of transfusions, sulfonamides, Miller-Abbot tubes, saline infusions, etc., when indicated are taken for granted.

On the other hand in the case of deaths following operation with the insertion of deep drains, autopsy usually shows that peritonitis at death is largely limited to the region of the drain. In these cases a frequent cause of death is intestinal obstruction

and the obstruction is nearly always found in the region of the drainage tract.

Sir Samson Handley⁹ believed that in generalized peritonitis death is never due to the peritonitis itself, but always to intestinal obstruction.

Shipley,¹⁰ in describing the experiences which led to his discarding drainage says, "But there were a certain number who came to grief and in almost every instance intestinal obstruction was the complication present. Even when this condition did not actually exist there was often a period of uncertainty because of the presence of paralytic ileus or incomplete obstruction due to angulation. In the spring of 1930, within a few weeks, four patients on whom I had operated for peritonitis following appendicitis and drained, developed mechanical obstruction and two of them died. At operation all four were completely obstructed by angulation of a loop of small intestines *in the drain tract. The remainder of the peritoneum was free of adhesions or any evidence of infection.*"

In neglected cases in which a retrocecal abscess has formed, intestinal obstruction is also a frequent factor in the mortality but the obstruction is more often due to mesenteric thrombosis than to mechanical obstruction.

An analysis of our last 374 cases of acute appendicitis follows:

In 216 patients the appendix was acutely inflamed; none were drained; none of the patients died

97 patients had gross perforation and frank peritonitis, either localized or diffuse; 54 were drained; 13 died; mortality 24 per cent; 43 were not drained; 4 died; mortality 9.53 per cent

Of the four deaths in the undrained series only one was due to peritonitis. The other three deaths were all instructive.

In the first, the tip of the gangrenous appendix was retroperitoneal under the root of the mesentery. An abscess formed under the root of the mesentery and fatal mesenteric thrombosis resulted.

The second patient was a woman seven and one-half months pregnant. She was

convalescent with a normal temperature when on the seventh day miscarriage occurred with fatal collapse.

The third patient was a man of sixty whose whole lower abdomen was full of thick, foul smelling pus. He had complete suppression of urine and died of uremia on the seventh day. When on the fourth day severe vomiting caused a disruption of his midline incision (made because of a mistaken diagnosis) the peritoneum was everywhere normal, no adhesions had formed, and no pus was found. The absence of adhesions and the complete disappearance of pus within four days has been a startling and constant finding in the few cases which we have had an opportunity to explore. Shipley reports similar experience.

If we eliminate these three cases, we have one death from peritonitis in forty-three patients treated by nondrainage, a mortality of 2.33 per cent. Furthermore our mortality of 24 per cent in drained cases was largely due to the complications which made drainage necessary. They included delayed operations on patients who were extremely ill on admission, with large abscesses which were simply opened and drained without removal of the appendix. All the patients in the fatal cases had been ill for periods of from forty-eight hours to five weeks.

The important point is that most of our undrained cases with the low mortality were those of diffuse peritonitis while practically all of the drained cases with much higher mortality had walled-off abscesses. The advocates of delay and the Ochsner treatment base their position on the assumption that mortality is less if the pus is allowed to become localized. This assumption is perhaps true if drains are used in cases of diffuse peritonitis. It certainly is not true if these patients are treated by early operation, removal of the appendix, aspiration of the purulent fluid and closure of the peritoneum without drainage.

Neither the amount of pus, the character of the pus, nor the area involved has anything to do with the question. If the source

of infection can be removed and if the peritoneum is intact, a drain is not only unnecessary but harmful.

To avoid residual abscesses the free pus should be removed with a Poole suction tube, especially from the pelvis. In order to do this effectively it is often necessary to separate loops of bowel agglutinated by fibrin. In the first forty-eight hours this fibrin is not organized into true adhesions. If a wet, gloved finger is gently used, loops can safely be separated without injury to the visceral peritoneum and no permanent adhesions will form. If this is not done the fibrin will exercise its function of forming a true adhesion to wall off the pus, with resultant abscess and permanent adhesions.

Diffuse peritonitis treated by nondrainage within forty-eight hours is no longer a serious problem. Every trace of pus has disappeared within four days and no adhesions occur provided that the source of infection is removed with no traumatizing of the peritoneal endothelium. (This implies the McBurney incision for direct approach and simple ligation without burial of the stump.)

Drainage is contraindicated in all types of diffuse peritonitis when the source of the infection can be eliminated, whether this be a pyosalpinx, perforated intestine or gunshot wound. We have closed without drainage more than fifty consecutive wounds in patients with acute salpingitis or tubo-ovarian abscess with no deaths, and no serious complications. Also, we have the satisfaction of knowing that few if any of these patients will suffer later from crippling adhesions.

SUMMARY

The nondrainage treatment is based not on theory but on overwhelming experimental and clinical evidence. Both experiment and experience have demonstrated beyond any doubt these facts:

1. It is physically and physiologically impossible to drain the peritoneal cavity by any means whatsoever.

2. In all types of peritonitis, removal of the source of infection, aspiration of pus, avoidance of injury to the endothelium and closure of the peritoneum is the only treatment required. If treated within forty-eight hours, the temperature will usually reach normal in three or four days, the exudate will be absorbed and permanent adhesions will rarely, if ever, be formed.

3. With such treatment deaths from peritonitis *per se* will seldom occur. Most deaths result from delayed operation, allowing abscesses to invade retroperitoneal tissues, from overwhelming toxemia, from mesenteric thrombosis, or from intestinal obstruction resulting from adhesions produced by the drainage tube.

4. Retroperitoneal tissues and the fascia and fat of the abdominal wall have none of the resistance of the peritoneum. Hence they should be drained or left wide open until healthy granulations form. Many such wounds can then be closed by secondary suture.

5. Since the success of nondrainage depends on the integrity of the peritoneum, a drain is indicated if the walls of an abscess are necrotic or lined with a shaggy gray membrane, if the retroperitoneal space is opened, or if bleeding cannot be completely controlled.

6. There need be no hesitation in gently separating fresh fibrinous adhesions in order to reach all collections of pus with the aspirator. Failure to do this may result in a localized abscess.

7. The more widespread the peritonitis, the less the indication for drains.

8. The time to operate is when the diagnosis is made. No surgeon lives who can tell with certainty what is going on inside the abdomen. With nondrainage there is nothing to be gained by delay and every-

thing to be gained by removal of the source of infection as early as possible.

9. Appendiceal peritonitis has been used to illustrate the principles underlying the treatment by nondrainage only because of the great mass of evidence available in that particular field. Removal of the source of infection and omission of the useless and harmful drain is equally important in the treatment of battle casualties. The validity of the method was established beyond question in the last two years of the first World War.

With a long war facing us the life of every fighting man who suffers a penetrating wound of the abdomen will depend largely on three things: Control of shock, sulfonamides and nondrainage of the peritoneal cavity.

REFERENCES

1. YATES, J. L. An experimental study of the local effects of peritoneal drainage. *Surg., Gynec. & Obst.*, 1: 473, 1905.
2. MORRIS, ROBERT T. My present position on appendix questions: and reference to the dawn of the fourth physiologic era in surgery. *J. A. M. A.*, 51: 644, 1908.
3. BUCHBINDER, J. R., DROEGMUELLER, W. A. and HEILMAN, F. R. Experimental peritonitis III. The effect of drainage upon experimental diffuse peritonitis. *Surg., Gynec. & Obst.*, 53: 726, 1931.
4. HAGGARD, W. D. and KIRTLEY, J. A. Treatment of acute spreading peritonitis following ruptured appendix. *J. A. M. A.*, 114: 1843, 1940.
5. KELLY, F. R. and WATKINS, R. M. Appendicitis in adults. *J. A. M. A.*, 112: 1785, 1939.
6. STORCK, A. H. Penetrating wounds of the abdomen. *Ann. Surg.*, 111: 775, 1940.
7. KING, H. JACKSON. The problems of acute appendicitis. *Am. J. Surg.*, 49: 104, 1940.
8. JACKSON, ARNOLD S. and PERKINS, ROLLIN. Reducing the mortality of perforated appendicitis. *Am. J. Surg.*, 59: 250, 1940.
9. HANDLEY, SIR SAMSON. Quoted by Cutting. *Post-operative Treatment*. P. 730. New York, 1932. Paul B. Hoeber.
10. SHIPLEY, A. M. and BAILEY, H. A. Treatment of appendicitis complicated by peritonitis. *Ann. Surg.*, 96: 537, 1932.



RECONSTRUCTION OF THE COMMON DUCT WITH A VITALLIUM TUBE

CASE REPORT

GASTON A. CARLUCCI, M.D.

Visiting Surgeon, Bellevue and Misericordia Hospitals

NEW YORK, NEW YORK

CASES have been reported in which following only a simple exploration of the common duct, a stenosing stricture or a fibrosis has developed with a resultant complete obliteration of the tube. To re-establish the flow of bile into the gastrointestinal tract at times is one of the most difficult procedures as the fibrotic process recurs and the new canal is obliterated. Having encountered one of these cases that required four operations before the continuity was definitely re-established by means of a vitallium tube, I believe it is worth reporting in detail:

CASE HISTORY

C. M., a male, thirty years of age, was first operated upon September 2, 1940, for chronic cholecystitis and cholelithiasis. A simple cholecystectomy was done. On September 9, 1940, a week later, he was operated upon again as he had developed an acute jaundice and the operating surgeon stated that thick, inspissated bile and sediment were found in his common duct. A T tube was placed in the duct which remained *in situ* for over eight weeks and then the biliary fistula gradually closed and the patient improved. His jaundice cleared and he apparently passed all his bile in his stools.

He was well until the end of January when he slowly became jaundiced. The stools were clay-colored and he had a terrific itch. There was very little temperature and very little loss of weight. His blood count showed concentration but no leucocytosis. His icteric index was 192 and his clotting time was three and one-half minutes. He came under my care at that time and after proper preoperative measures he was explored on February 18, 1941.

At this operation after dividing a mass of adhesions the base of the liver was finally exposed with great difficulty, and what ap-

peared to be a remnant of the common duct was identified. It had been replaced by a long, thick fibrous band, and although in the central portion there was a small lumen with some fluid, it was completely stenosed at the base of the liver and at the point where it disappeared behind the duodenum. After a great deal of difficulty the stenosis at the upper end was broken through and a catheter was inserted into the base of the liver. The patient was pretty well shocked by this time and the abdomen quickly closed. He was given a blood transfusion and his general condition improved but it was not until the following day that a profuse drainage of bile began. As the possibility of a malignancy was considered, some of the tissue removed about the duct was examined but this was reported as only chronic inflammatory tissue. He left the hospital on March 29th with a well established biliary fistula, and the stools acholic.

On May 14, 1941, he was re-admitted to Misericordia Hospital as the biliary fistula had gradually closed. On the day preceding this admission, following an attempt to pass a bougie into the tract, the patient had a severe chill, sharp abdominal pain and a temperature of 104.4°F. A white blood cell count showed 23,000 cells and 95 per cent polymorphonuclears. There was acute tenderness over the whole liver and a diagnosis of acute hepatitis was made. He was given 4 Gm. of sulfathiazole every four hours and poultices were applied to the abdominal wall. His temperature dropped to normal in four days and the fistula opened up. A catheter was introduced into the sinus tract and the patient discharged.

On June 8, 1941, he again entered the hospital. At this time the catheter was still in the tract, the bile was being collected in a bottle and the patient was taking about 4 ounces of his own bile daily with his food, without nausea. After proper preoperative preparation

he was operated upon June 11th. The biliary fistula was dissected out and the cutaneous end was implanted into the prepyloric end of the



FIG. 1. Showing catheter in biliary fistula tract collecting bile in bottle. The shiny reflection on the skin is from the aluminum powder.

stomach suturing this around the tract and to the inferior surface of the liver. A small cigarette drain was left near the anastomosis

the presence of bile. On June 14th, the drain was removed as there was no biliary drainage. However, several days later there were some bile stains on the dressings. Within a few days the stools were found to contain bile and the patient went home.

On October 13, 1941, he was re-admitted because in the last three months he had had several attacks of jaundice with fever and now was again jaundiced and the stools were acholic. After a consultation it was decided that he again had strictured and should be explored. The next day he was reoperated upon. A mass of adhesions were found and after these were divided, it was found that the stricture had reformed at the base of the liver. The rest of the tract had become a small fibrous tube with some dark fluid in it. The opening into the stomach was closed. The stricture at the base of the liver was split again and one end of a T tube introduced into the hepatic ducts and then the old fistulous tract sutured around the tube and the other end inserted into an opening that had been made into the stomach. The whole area was reinforced about the tube and the long end brought out on the abdominal



FIG. 2. X-ray film showing vitallium in place nine months after the last operation.

and the abdominal wall closed. His post-operative course was faintly stormy; the temperature rose nearly to 105°F. and then slowly dropped. Aspiration of the Levin tube that had been introduced into the stomach showed

wall; the usual drain was inserted and the abdominal wall closed. Bile began to drain immediately.

Again he had quite a reaction, but he eventually left the hospital on November 3rd with

most of the bile coming through the tube and only a faint trace in the stools. About the end of November, the tube came out. On December 15th, he was re-admitted as the fistula had closed; there was no bile in the stools and he was severely jaundiced. The following day the closed end of the tract on the abdominal wall was excised and this allowed a free flow of bile. On December 23rd, some lipiodol was injected into the tract but only a very small amount entered. The x-ray film was read by Dr. R. Pound who reported that the lumen of the tract was very narrow and that there was a stenosis or contraction at the junction of the hepatic and common ducts. Apparently, the communication into the stomach had again closed.

On January 28, 1942, he entered Bellevue Hospital for study. His icteric index was 77. Aspiration of gastric contents showed no evidence of bile but acidity within normal limits. A flocculation test did not show liver damage. His jaundice was severe. The wound in the skin was re-opened but shortly afterward closed again, and the patient decided to go home unimproved.

On February 26th, it was decided to make a final attempt to re-establish a communication between the liver and the gastrointestinal tract. At this operation a stricture was found immediately beneath the skin, then a thinned-out tract extending to the base of the liver, where the usual firm stricture was found again. There was no communication with the stomach. The old abdominal scar was excised and the usual dissection carried out. When the stricture at the base of the liver was found it was split widely, clear bile obtained again and then the region about the opening cleared thoroughly. The wide end of a 4 cm. vitallium tube was inserted into what was left of the common duct. It was anchored here with silk sutures, then the other end of the tube inserted into a small opening in the prepyloric end of the stomach. The rest of the opening was closed with chromic sutures and then the stomach sutured close around the tube and to the inferior surface of the liver. A small drain was introduced and the abdominal wall closed with mattress sutures and silk.

He reacted well but on the third day he apparently had a massive hemorrhage from his stomach as he passed nearly 500 cc. of pure blood in his stool. He received another transfusion and although he continued to pass

tarry stools for about a week he steadily improved and regained his strength. At the end of the tenth day there was no further bile stain on the dressings and the following day the stools were positive for bile. He left the hospital sixteen days after this operation with the wound completely healed. A fluoroscopic examination showed the vitallium tube in place. His stools were normal in color and his icteric index had dropped to 33.

Throughout all these operations the patient never had any gastric upsets and never vomited up any bile.

Since this last operation the patient has regained his strength, put on about twenty pounds, eats well, digests his food well and has not re-opened his skin fistulous tract. At present the x-ray film shows the vitallium tube still *in situ*.

COMMENT

This case apparently is similar to others already reported in which a fibrosis and strictures occur in the common duct following a simple cholecystectomy.

There is no doubt that the patient had a functioning common duct following the second operation as he was not jaundiced for many months and there was only a gradual obstruction after that.

At the third operation there was only a fibrosed tube with two strictures representing the remnants of the common duct. All the other operations showed the same fibrotic process developing over and over, with one stricture at the base of the liver and the other at the skin margin while the opening into the stomach would become obliterated.

It is of interest to note that the usual steps in the re-establishing of the continuity of the biliary system with the gastrointestinal tract all failed in this case until the vitallium tube was used. Apparently this procedure (it is now nine months) has succeeded.

Finally, it is to be noted that the patient was able to drink his own bile and has had no gastric disturbance in spite of the fact that he has a permanent biliary fistula into his stomach.

RECURRENT LARYNGEAL NERVE IN THYROID SURGERY

TRIANGLE FOR ITS RECOGNITION AND PROTECTION

MAX MICHAEL SIMON, M.D.

Senior Attending Surgeon, St. Francis Hospital

POUGHKEEPSIE, NEW YORK

SAFE thyroid surgery demands a detailed knowledge of the surgical anatomy of the recurrent laryngeal nerve. Notwithstanding the centuries that have elapsed since the reputed discovery of the recurrent laryngeal nerve by Galen,¹⁴ it is doubtful if there has been another nerve in the body which has given rise to so many diverse and fanciful theories to account for its anatomical peculiarities.

Anatomists and surgeons^{6,8,9,10,12,15,20,30,35,39} still differ considerably in their descriptions of the course and structure of the recurrent laryngeal nerve. Some authors describe the nerve as lying directly in the tracheoesophageal groove; while others describe it as lying in a lateral position. Charles C. Higgins¹⁸ carried out a series of dissections to determine the position of the nerve and describes it as passing obliquely upward to the side of the trachea from its point of origin. Grile⁷ has described this nerve as an exceedingly soft and very vulnerable structure. He states that the recurrent laryngeal nerve is "naked" as is the brain and spinal cord, and that the slightest direct or even indirect pressure on the nerve interferes with its conduction and immediately changes the voice. Berlin,¹ however, presents clinical and histological evidence to show that the recurrent laryngeal nerve closely resembles an ordinary peripheral nerve with all the firmness and tensile strength of a peripheral nerve and that its vulnerability to trauma is not as great as previously supposed. Lahey,²³ who has demonstrated the recurrent laryngeal nerve in 3,000 operations, states that it is of sufficient size so that it can be dissected out and visualized without harm, and that it has sufficient body so that it can readily be

palpated as it is pushed against the rigid tracheal wall. These observations^{1,23} are in accordance with the animal experiments of Judd, New and Mann²¹ who demonstrated that stretching the recurrent laryngeal nerve does not result in any impairment of its nerve function, but that pinching causes temporary paralysis, and that permanent paralysis follows only ligation or severance of the nerve. More recent observations have confirmed this.^{1,7} It is interesting to note that Doyen,¹¹ Sebileau, Victor Pauchet,^{38,32} and others⁴ many years ago advocated and considered dissection and visualization of the recurrent laryngeal nerve a safe procedure in the performance of thyroidectomy.

Thyroidectomy is now a common operation and with such a low mortality that it is being performed more frequently by an increasing number of surgeons. The recurrent laryngeal nerve, however, still dignifies the operation because various clinics continue to report from 1½ to 5 per cent of nerve injuries. And it is probable that the incidence of injury to this nerve is even higher than the present inadequate statistics would indicate, for the many methods of treatment for paralysis of this nerve which have been described must bear witness to the increasing frequency of injury. Massage, electrical and local applications have been advocated. Recently, contributions to recurrent nerve anastomosis have been made by Frazer,¹³ Charles Ballance,⁴¹ Lahey and Hoover.²⁴ However, no method of treatment to date has yielded satisfactory results and hence prevention is paramount. Only those who have seen injuries to this nerve severe enough to require tracheotomy can appreciate its

importance. The nightmare of bilateral nerve paralysis is always uppermost in the surgeon's mind when doing thyroidectomy. The writer believes that these injuries are largely avoidable and it is the purpose of this paper to point out an anatomical guide to the position of this nerve in relation to the thyroid gland.

Kocher,²² the father of thyroid surgery, advocated partial thyroidectomy under local anesthesia because in this manner the patient could co-operate by speaking and thus register any injury to the nerve. Hertzler¹⁷ and many other surgeons have continued to advocate local anesthesia for this reason, and attempt to avoid injury of the nerve by separation of the posterior capsule from the back part of the gland. This procedure is believed by some to obviate all dangers of nerve injury because of the concept that the nerve is external to the capsule, and when the capsule is stripped back the nerve is carried with it out of harm's way. They would prefer not to see the nerve during thyroidectomy. While every student of surgery knows the general position of the recurrent laryngeal nerve, yet the greatest tragedies which follow thyroid surgery result from injury to this structure. Berlin¹ and Lahey²³ have, therefore, advocated routine dissection and visualization of the nerve in thyroidectomy. The latter recently reported a series of 19,700 thyroidectomies with a mortality of 0.76 per cent and a reduction of the incidence of recurrent laryngeal nerve injury from 1.6 to 0.3 per cent in the last 5,000 cases in which the nerve was visualized. These observers have demonstrated that routine dissection and demonstration of the nerve, even palpation while on moderate stretch has caused no interference with its function either immediate or late. To dissect and visualize the recurrent laryngeal nerve it is necessary to elevate the lobe of the gland out of its bed. While some observers⁷ have taught that recurrent laryngeal nerve injury is caused by traction on the gland during removal, our present knowledge, based on anatomical and surgi-

cal studies on large series of cases, appears to confirm the fact that injury to the nerve is more frequently the result of operative trauma. It is usually direct injury by forceps or knife or by rough sponging or by rough packing to control bleeding that recurrent laryngeal nerve damage is done. Competent observers⁷ have pointed out that exposure of the recurrent laryngeal nerve in thyroid surgery is not only a safe and justifiable procedure but that it tends to diminish if not largely eliminate injury to the nerve. Of course, there will be the occasional poor risk patient with Graves disease in whom it may prove difficult to find the nerve and in whom the saving of time will be of greater importance than the demonstration of the nerve. However, any surgeon who has made himself perfectly familiar with the usual position of the recurrent laryngeal nerve by having visualized it in fifty or more cases is less apt to injure this structure.

Exposure is one of the fundamental principles of surgery. What one sees he can avoid and anything which cannot be seen, especially if it is in the operative field is in danger of injury. The finding of the recurrent laryngeal nerve, however, has proved difficult at times and I believe this is probably the chief reason why so many operators have preferred not to visualize the structure. The writer encountered this same difficulty in the beginning and solved this problem through a small anatomic experience gained through dissection of this region and the performance of thyroidectomy in more than 100 patients. In all of those cases thyroidectomy was done under local infiltration anesthesia ($\frac{1}{2}$ per cent novocain). There was, therefore, no race against time. With local anesthesia the respiration is quiet, and the venous pressure is not increased as is inevitable in any closed system of general anesthesia; hence the bleeding is less. This permits a more anatomic operation in which meticulous attention can be paid to hemostasis and anatomic detail. The purpose of this paper is to pass on this anatomic wrinkle in the

hope that it may prove as helpful a guide to others as it has to me in the visualization of the recurrent laryngeal nerve.

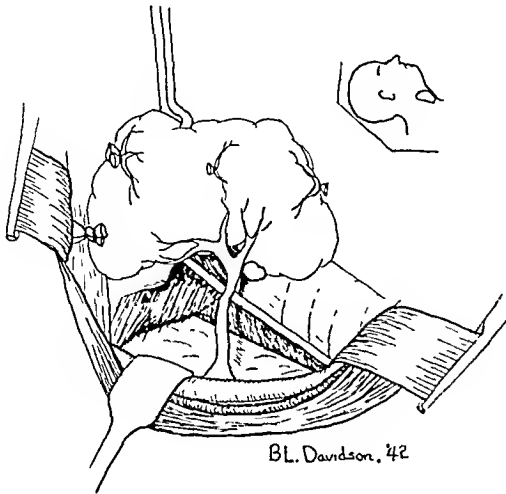


FIG. 1. Exposure of the triangle on the right side. The superior pole has been doubly ligated and divided and the middle and inferior thyroid veins have been ligated and detached. The lateral lobe of the thyroid gland has been dislocated and rotated from its bed exposing the posterolateral surface of the lobe. With the lobe thus elevated and the internal jugular vein and common carotid artery retracted outward, the loose areolar tissue between these vessels and the trachea is exposed. In this area the common carotid artery, the inferior thyroid artery and the recurrent laryngeal nerve form the triangle.

A good light and a dry field are essential. After the superior pole has been doubly ligated and divided, and the middle and inferior thyroid veins have been ligated and detached, the lateral lobe of the thyroid can be dislocated and rotated easily from its bed, thus exposing the posterolateral surface of the lobe. With the lobe elevated and rotated toward the midline and the internal jugular vein and common carotid artery held outward by a blunt retractor, the loose areolar tissue between these vessels and the trachea is exposed. (Fig. 1.) In this area the trunk of the inferior thyroid artery can be felt pulsating and seen emerging from underneath the common carotid artery just below the level of the cricoid cartilage. (Fig. 2.) The carotid tubercle (Chassaignac's tubercle) can be felt at this level against which the common carotid artery

can be compressed. The carotid tubercle and the cricoid cartilage are at the same level and are fixed guides to the inferior

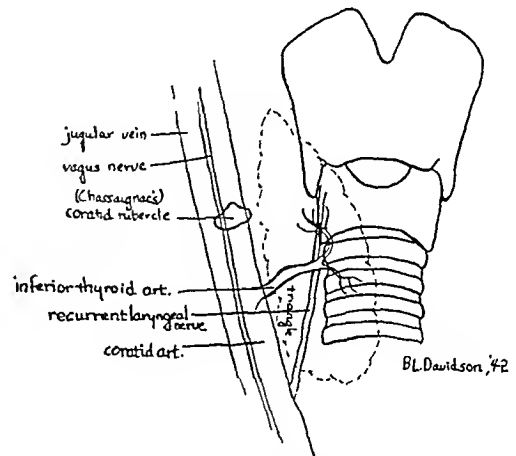


FIG. 2. Diagram showing the triangle in its relation to the larynx, trachea and large vessels. Note that the carotid artery can be compressed is at the same level as the cricoid cartilage (sixth cervical vertebra). The triangle is below that level.

thyroid artery which emerges just below their level to enter the gland. The vessel enters the lobe transversely on its posterolateral aspect at about the junction of its lower and middle thirds. (Fig. 2.) Text-books of anatomy have pictured the inferior thyroid artery as a vermilion colored structure entering the inferior pole of the thyroid gland, a direct invitation to a ligature. This may be true for the inferior thyroid vein which frequently emerges at the lower pole. Actually, the inferior thyroid artery is deeply situated as illustrated and described above. The inferior thyroid artery can be palpated and seen as it runs transversely from underneath the carotid artery to approach the junction of the lower and middle thirds of the lobe. After the inferior thyroid artery is located in the manner described it can be exposed by blunt dissection and isolated and a ligature passed around it with a carrier if necessary. Usually by the time the inferior thyroid artery has been isolated the course of the recurrent laryngeal nerve has been visualized.

The writer has noted a constant triangular relationship between the common



FIG. 3. Actual photograph of the author's dissection of the recurrent laryngeal nerve showing the triangle on the right side. The inferior horn of the thyroid cartilage has been bared in order to show the recurrent laryngeal nerve terminating under the horn. The superior pole vessels have not been severed in order to indicate the preferred site of ligation; that is, above the level of the inferior horn of the thyroid cartilage. Note the parathyroid body just outside the triangle.



FIG. 4. Actual photograph of the author's dissection of the recurrent laryngeal nerve showing the triangle on the left side. The recurrent laryngeal nerve runs somewhat deeper on the left side. It courses up along the tracheo-esophagal groove to terminate under the inferior horn of the thyroid cartilage. The triangle however, is maintained. Note superior pole vessels above the level of the inferior horn of the thyroid cartilage. Note that the esophagus is more prominent on the left side and partially forms the floor of the triangle whereas on the right side the floor is formed almost entirely of areolar connective tissue.

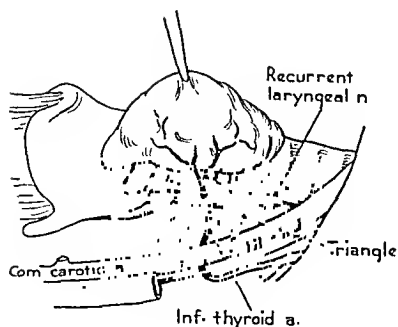


FIG. 5.

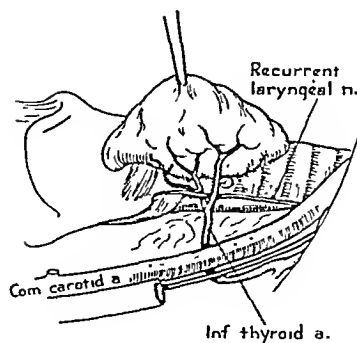


FIG. 6.

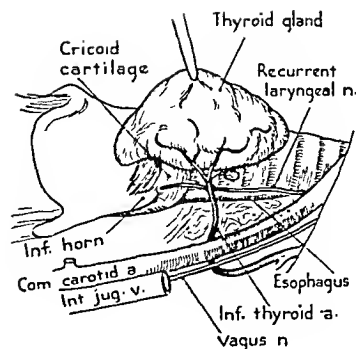


FIG. 7.

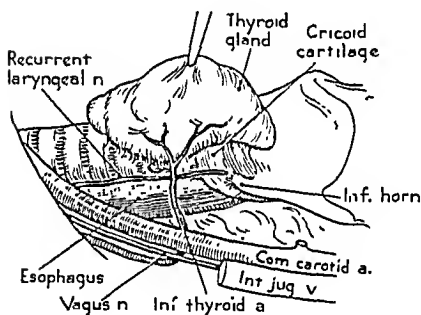


FIG. 8.

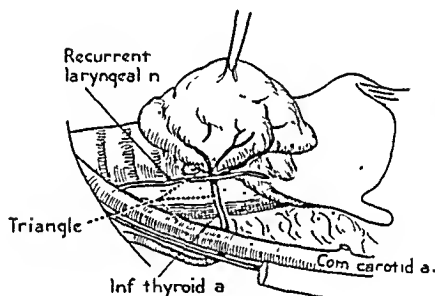


FIG. 9.

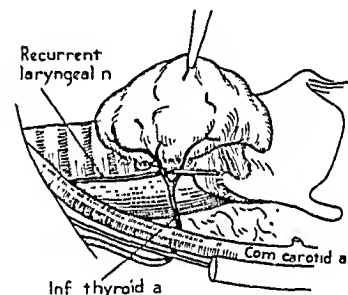


FIG. 10.

FIG. 5. Drawing of the author's dissection showing the triangle on the right side with its three boundaries. The recurrent laryngeal nerve is here anterior to the inferior thyroid artery. This is an occasional relationship and occurred seven times in eighty-six triangles dissected by the author in forty-three cadavers.

FIG. 6. Drawing of the author's dissection showing a triangle on the right side with the recurrent laryngeal nerve passing between the branches of the inferior thyroid artery. This is an uncommon relationship and occurred four times in the eighty-six triangles. Note the intimate relationship of the upper branch of the inferior thyroid artery to the recurrent laryngeal nerve.

FIG. 7. Drawing of the author's dissection showing the triangle on the right side with the recurrent laryngeal nerve posterior to the inferior thyroid artery. This is the usual relationship and occurred thirty-two times in the eighty-six triangles. Note that the floor of the triangle is formed almost entirely by loose areolar connective tissue.

FIG. 8. Drawing of the author's dissection showing a triangle on the left side. The recurrent laryngeal nerve is posterior to the inferior thyroid artery. This is the usual relationship and occurred thirty-three times in the eighty-six triangles dissected. Note that the esophagus is more prominent on the left side and partially forms the floor of the triangle.

FIG. 9. Drawing of the author's dissection showing a triangle on the left side with the recurrent laryngeal nerve anterior to the inferior thyroid artery. This is an occasional relationship and occurred eight times in the eighty-six triangles. Note intimate relationship of upper branch of inferior thyroid artery to the recurrent laryngeal nerve.

FIG. 10. Drawing of the author's dissection showing another triangle on the left side with the recurrent laryngeal nerve running between the branches of the inferior thyroid artery. This is a rare relationship and occurred twice in the eighty-six triangles.

carotid artery, inferior thyroid artery and the recurrent laryngeal nerve. (Figs. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. See all figures.) The inferior thyroid artery emerges transversely, occasionally with a loop, from underneath the common carotid artery almost at a right angle. It forms the base of a triangle, the other two boundaries of which are the common carotid artery and the recurrent laryngeal nerve. The common carotid artery is somewhat larger than a goose quill, is yellowish in color, pulsates visibly and is easily recognized. The inferior thyroid artery, a branch of the thyrocervical trunk, is often somewhat larger than the superior thyroid artery, yellowish in color, pulsates and is easily recognized as it approaches the posterolateral surface of the gland. The recurrent laryngeal nerve is flattened, firm, somewhat smaller than the diameter of a match, is white in color, and can be seen running obliquely toward the trachea against which it can be palpated. It crosses usually behind, sometimes in front of the inferior thyroid artery, occasionally between its branches. (Figs. 5 to 10.) A triangle is thus formed with these three structures as boundaries. (Figs. 1 to 10.) This area is not infrequently the location of a parathyroid body. I have noted this triangular relationship on numerous occasions, and it was apparent to me that this triangle was similar in size and importance to Calot's triangle in biliary surgery. Calot's triangle is formed with the cystic artery as a base and the cystic duct and common hepatic duct forming the other two boundaries. Keeping Calot's triangle in mind has prevented injury in a vital area of cholecystectomy. Keeping the triangle described above in mind helps to prevent injury in a vital area of thyroidectomy. Nature is usually constant. The constancy of location of the recurrent laryngeal nerve has been noted by many others.^{7,2,23} This constancy of location of the recurrent laryngeal nerve has been shown to persist no matter what the type

of goiter and regardless of its size or depth in the chest.²³

This triangular zone is thus visualized by going from the general to the particular. The carotid artery is immediately apparent, the inferior thyroid artery is easily identified emerging from under the carotid artery just below the level of the cricoid cartilage and carotid tubercle. The angle of approach of the recurrent laryngeal nerve here is quite constant as it passes upward obliquely to cross behind the inferior thyroid artery on its way up to the larynx. Thus the triangle is completed. The nerve then continues up and becomes intralaryngeal by passing under the lowest fibers of the inferior constrictor muscle. The triangular relationship described above can be visualized only when the operator is on the same side as the lobe. When ready to remove the left lobe, one must cross over so that the operator will be on the same side of the patient as is the lobe that is to be removed. While the nerve runs somewhat deeper on the left side, here, too, it crosses the inferior thyroid artery usually from behind and the triangular relationship is maintained. (Figs. 4, 8, 9, 10.) Anomalies of the recurrent laryngeal nerve are rare²³ but can be recognized if the triangle is sought for. The only anomaly which has been described in the literature is the anomalous course of the recurrent laryngeal nerve which seems to occur in about one in every 500 cases. In this case reported by Pemberton³⁴ the nerve separated from the trunk of the vagus at the level of the cricoid cartilage. The recurrent laryngeal nerve proceeds upward, after completing the triangle, to enter the larynx at the level of the cricothyroid articulation. The inferior horn of the thyroid cartilage can be felt at this level. (Figs. 1, 2, 3, and 5 to 10.) The nerve trunk can be palpated below the inferior thyroid artery at this point. Since the recurrent laryngeal nerve becomes intralaryngeal at the level of the inferior horn of the thyroid cartilage, it has been my practice never to ligate the superior

pole vessels of the thyroid without first palpating this inferior horn. If the superior pole vessels are, therefore, ligated above the level of the inferior horn of the thyroid cartilage, the terminal branch of the recurrent laryngeal nerve can be avoided.

Injury to the recurrent laryngeal nerve, however, is more often lower down and as a result of the relation of this nerve with the inferior thyroid artery.^{7,23} It is the upper branches of the inferior thyroid artery as they approach the trachea to enter the gland that are not infrequently torn or cut across during thyroidectomy. It is in attempts to control these bleeding points when they retract at the laryngo-tracheal junction that the hemostat is liable to catch the nerve just before it dips into the inferior constrictor muscle. (Figs. 1, 2, 3, 6 and 9.) The writer has discussed this point with Doctor Charles V. Morrill, professor of anatomy at Cornell University Medical College, and it seemed quite obvious to us both that attempts to control bleeding by direct clamping and ligation of the upper branches of the inferior thyroid artery endanger the recurrent laryngeal nerve. When sharp bleeding in this area occurs extracapsular ligation of the trunk of the inferior thyroid artery is safer. Routine ligation of this vessel, however, is not necessary or desirable because this vessel must supply not only the remaining thyroid gland but the trachea, esophagus, muscles and parathyroids as well. Visualization of the inferior thyroid artery is highly desirable, however, for then it can be ligated if necessary, and in addition it forms a most important guide to the position of the recurrent laryngeal nerve since it forms the base of the triangle.

The triangle described above has been of considerable help to the writer as a guide to the position and protection of the recurrent laryngeal nerve; and the writer believes that it is a good relationship for the thyroid surgeon to keep in mind to help avoid trouble. Technical operative complications undoubtedly contribute to

many thyroid deaths and it is in this vital triangular area where the complications occur. While hemorrhage from the superior thyroid can be controlled by compressing the carotid artery, hemorrhage from the branches of the inferior thyroid artery, however, cannot be controlled in this way since the inferior thyroid artery is a branch of the thyrocervical trunk. (Figs. 5 to 10.) Since the inferior thyroid artery is often larger than the superior and its branches in such close relationship to the recurrent laryngeal nerve, it is important to visualize the main trunk of this vessel before removal of the gland is begun. Inadequate control of bleeding from the inferior thyroid branches often prolongs the operation. The anatomic relations are interfered with, and attempting to control this hemorrhage by direct clamping or suture of the bleeding points may result not only in injury to the recurrent laryngeal nerve but to the parathyroids and even the trachea. (Note the intimate relationship of the inferior thyroid artery to the recurrent laryngeal nerve, trachea and parathyroid in the photographs and diagrams.) The prime requisite is, therefore, adequate exposure and especially of the triangular zone described above. Early exposure of this triangle before the removal of the gland is begun visualizes the course of the nerve and provides the trunk of the inferior thyroid artery for the control of hemorrhage from its branches should this become necessary. The writer has refrained from reporting this triangular relationship as an aid to visualization of the recurrent laryngeal nerve until he had employed it in a sufficient number of cases and found the relationship to be constant. A reasonably complete review of available American, English, French and German literature reveals that no one has described this method of visualizing the nerve as completing the boundary of a triangle.

CONCLUSIONS

1. The exposure of the recurrent laryngeal nerve in thyroid surgery has been

proved to be a safe and justifiable procedure and has markedly reduced the incidents of recurrent laryngeal nerve injury.

2. An anatomical triangle is described whose base is the inferior thyroid artery and whose apex is formed by the common carotid artery and the recurrent laryngeal nerve.

3. The described triangle is easily identified and remembered. It serves (1) as a guide and guard to the recurrent laryngeal nerve; (2) as a guide to the inferior thyroid artery; and (3) as a guide and guard to a parathyroid body.

4. It emphasizes a vital triangular area in thyroid surgery just as Calot's triangle brings to mind and emphasizes a vital triangular area in biliary surgery.

The author wishes to acknowledge with grateful appreciation the kind assistance of Dr. H. P. Carpenter, Pathologist to St. Francis Hospital; Dr. Louis Muzzicato my assistant, and Dr. Charles V. Morrill, Associate Professor of Anatomy, Cornell University Medical College.

REFERENCES

- BERLIN, DAVID D. The recurrent laryngeal nerves in total ablation of the normal thyroid gland. *Surg., Gynec. & Obst.*, 60: 19, 1935.
- BERLIN, DAVID D. and LAHEY, FRANK H. The relation of recurrent to the inferior thyroid artery and the relation of the superior to abductor paralysis. *Surg., Gynec. & Obst.*, 49: 102-104, 1929.
- BICKHAM, WARREN STONE. *Operative Surgery*. 3rd ed. 1930. W. B. Saunders.
- BIER, AUGUST, BRAUN, HEINRICH and KUMMELL, HERMANN. *Chirurgische Operationslehre*. Band 1. Leipzig. 1914. Herausgeber.
- BLUMGART, H. L., LEVINE, S. A., and BERLIN, D. D. Congestive heart failure and angina pectoris. The therapeutic effect of thyroidectomy on patients without clinical or pathologic evidence of thyroid toxicity. *Arch. Int. Med.*, 51: 866, 1933.
- CALLANDER, C. LATIMER. *Surgical Anatomy*. Philadelphia, 1939. W. B. Saunders.
- CRILE, GEORGE. *Diagnosis and Treatment of the Thyroid Gland*. Philadelphia, 1932. W. B. Saunders.
- CUNNINGHAM, D. J. *Textbook of Anatomy*. 5th ed. Baltimore, 1923. William Wood & Co.
- DAVIS, G. G. *Applied Anatomy*. 6th ed. 1924.
- DEAVER, JOHN B. *Surgical Anatomy*. Vol. 11. Philadelphia, 1900. P. Blakiston's Son & Co.
- DOYEN, E. *Surgical Therapeutics and Operative Technique*. Vol. 11. New York, 1928. William Wood.
- FOWLER, C. H. and HANSON, W. A. Surgical anatomy of the thyroid gland with special reference to the relations of the recurrent laryngeal nerve. *Surg., Gynec. & Obst.*, 49: 59-65, 1929.
- FRAZIER, C. H. and MOSSER, W. B. Treatment of recurrent laryngeal nerve paralysis by nerve anastomosis. *Surg., Gynec. & Obst.*, 43: 134-139, 1926.
- WALSH, JOSEPH. Galens' discovery. *Ann. Med. History*, 8: 176-184, 1926.
- GRAY, HENRY. *Anatomy of the Human Body*. 20th ed. Philadelphia, 1918. Lea & Febiger.
- GUTTMAN, V. Sur l'etiologie de la paralysie du nerf recurrent. *Arch. internat. de laryng.*, 29: 15-21, 1923.
- HERTZLER, ARTHUR E. *Diseases of the Thyroid Gland*. 3rd ed. 1935. C. V. Mosby Co.
- HIGGINS, CHARLES D. *Ann. Surg.*, 85: 827, 1927.
- HOESSLY, H. Ueber Nerveneimplantation bei Recurrenslahmungen. *Beitr. z. klin. Chir.*, 99: 186-192, 1916.
- HOOPER, F. H. The anatomy and physiology of the recurrent laryngeal nerves. *New York M. J.*, 46: 25-29; 63-66; 99-103; 150-152, 1887.
- JUDD, F. S., NEW, G. B. and MANN, F. P. Effect of trauma on laryngeal nerve. *Ann. Surg.*, 68: 257, 1918.
- KOCHER, THEODOR. *Textbook of Operative Surgery*. Vol. 11. 1911. The Macmillan Co.
- LAHEY, FRANK H. Routine dissection and demonstration recurrent laryngeal nerve in subtotal thyroidectomy. *Surg., Gynec. & Obst.*, 66: 775-777, 1938.
- LAHEY, FRANK H. and HOOVER, WALT B. Injuries to the recurrent laryngeal nerve in thyroid operations. *Ann. Surg.*, 108: 545-562, 1938.
- LEWIS, DEAN. *Practice of Surgery*. Vol. 6. Hagerstown, 1929. W. F. Prior & Co.
- LILIENTHAL, HOWARD. *Thoracic Surgery*. 11: p. 77. Philadelphia, 1925. W. B. Saunders.
- MEANS, J. F. *The Thyroid and its Diseases*. Philadelphia, 1937. Lippincott.
- MILANITCH, N. Note sur une anomalie d'origine des gros troncs de la crosse de l'aorte accompagnée d'une anomalie de trajet du nerf recurrent droit. *Bull. et mém. Soc. Anat. de Par.*, 94: 230-233, 1924.
- MORRILL, CHARLES V. Personal communication.
- MORRIS'S *Human Anatomy. A Complete Treatise*. 10th ed. Philadelphia, 1942. Blakiston Co.
- NORLAND, MARTIN. The larynx as related to surgery of the thyroid based on an anatomical study. *Surg., Gynec. & Obst.*, 51: 449-459, 1930.
- PAUCHET, VICTOR. *Treatment of Goitres: Practical Surgery Illustrated*. Vol. 111: 73-115. 1925. Ernest Benn, Ltd.
- PAYR. Plastik am Schildknorpel zur Behebung der Folgen einseitiger Stimmbanblähmung. *Deutsche med. Wchnschr.*, 41: 1265-1270, 1915.
- PEMBERTON, J. DE J. and BEAVER, M. G. Anomaly of the right recurrent laryngeal nerve. *Surg., Gynec. & Obst.*, 54: 594, 1932.
- PIERSOL, G. A. *Human Anatomy*. 8th ed. Philadelphia, 1923. Lippincott.

36. SCHMERZ, H. Zur operativen Beeinflussung der Recurrenslähmungen. *Beitr. z. klin. Chir.*, 99: 186-192, 1916.
37. SCHMIEDEN, V. Criticism and recommendation of Pay's laryngoplasty in paralysis of recurrent nerve. *München. med. Wchnschr.*, 73: 558-559, 1926.
38. PAUCHET, VICTOR. Practical Surgery Illustrated. Sebileau, Ma Technique de l'extirpation des Goîtres. Paris Medical, January 8 and 15, 1921.
39. SPALTEHOLZ, WERNER. Hand Atlas of Human Anatomy. Vol. 111, 732. J. B. Lippincott Co.
40. ZIEGELMAN, E. F. Laryngeal nerves. Surgical importance in relation to the thyroid arteries, the thyroid gland and the larynx. *Arch. Otolaryngol.*, 18: 793, 1933.
41. BALLANCE, C. Results Obtained in Some Experiments in which Facial and Recurrent Laryngeal Nerves Were Anastomosed with Other Nerves. *Brit. M. J.*, 2: 349-354, 1924.



EXPERIMENTS suggest that the disproportionate degree of tissue destruction caused by small high-velocity bomb splinters is due to the fact that particles lying in their path are thrown radially with sufficient violence to leave a central cavity around which tissues at some distance from the track are momentarily stretched.

RELATIONSHIP OF THYROTOXICOSIS TO THE PRESENT WAR EFFORT

ITS MODERN TREATMENT

ABRAHAM O. WILENSKY, M.D.

NEW YORK, NEW YORK

THE medical aspects of the present military emergency have been distinguished to a large extent by the number of nervous and psychiatric problems which the drafted men are presenting. Undoubtedly, a certain proportion of these will find their bases in a congenital imbalance of the nervous mechanism ordinarily intensified and brought to the fore by the problems of civil life and now considerably multiplied in its intensity by the strange environment of military life and of the fears which it brings forward. Some of these symptomatologies, at least, will acquire the characteristics of true thyrotoxicosis: exophthalmic goiter, Graves disease, Basedow's disease, primary hyperthyroidism. It is important that these cases be recognized by the draft boards before induction into the army, or, at least, very soon thereafter so that intensification of the disease by military environment can be forestalled. Proper cure of the disease will result in an individual who, while not fit in any way for combatant service, can and will still be able to fulfill many of the necessary noncombatant duties.

The statistics of Love and Davenport compiled from the conscription records of the War Department for the first World War, give the approximate frequency of endemic goiter among young men of draft age in this country. A regional intensity is shown in that there is a greater incidence and a larger number of severe cases in the middle northwest than on the eastern coast of the United States. According to Plummer, there was an increase in the intensity of the disease in the middle west from about 1924 to 1930 with a definite

decrease since then in intensity and in the number of cases in which crises have occurred.

The following table contains a summary of this information:

State	Proportion for All Types In- cluding Exoph- thalmic Goiter	Proportion for Endemic Goiter, per 1,000	Proportion for Exoph- thalmic Goiter
Idaho	30	27	3
Oregon	33	26	7
Washington	33	23	10
Montana	24	21	3
Utah	20	16	4
Wyoming	18	15	3
Alaska	21	13	8
Wisconsin	22	14	8
Michigan	18	11	7
North Dakota	12	9	3
Minnesota	11	8	3
Iowa	10	7	3
Illinois	13	8	5
Indiana	10	6	4
Ohio	11	6	5
West Virginia	12	8	4
Nevada	8	6	2
Colorado	9	5	4
North Dakota	12	9	3
South Dakota	7	4	3
Nebraska		2	
Kansas		1	
California	6	4	2
Missouri	9	4	5
Virginia	7	3	4
Pennsylvania	9	4	5
Rest of U. S.	2		

According to Pepper, there were 6,219 cases of exophthalmic goiter (2.78 per 1,000) in the armed forces of the United States during the first World War and 1,176 cases of simple goiter. He very rightly remarks that there is little reason

to believe that this disease will fail to occur just as frequently now. With the increased emotional aspects of this war I am inclined to believe that the number will be larger. This tendency seems to be shown in the statistics of McKinley who found that in a total of 209 rejections by the Medical Advisory Board for Hennequin, Sherburne, Scott, Wright and Carver counties, comprising both rural and urban communities, 7.6 per cent were rejected for hyperthyroidism. This is rather a large number.

The statistics on exophthalmic goiter compiled by Love and Davenport probably indicate a too high incidence of the disease. More likely the large majority had diffuse colloid or adenomatous goiters. True exophthalmic goiter was frequently not distinguished from the condition later classified in the army either as irritable heart of soldiers, disordered action of the heart, effort syndrome, or neurocirculatory asthenia, the incidence of which under the conditions then prevailing was high. This was emphasized by Peabody, Wearn and Tompkins for the American Army and by Lewis and his co-workers for the British Army, and was first noted by Da Costa in the American Civil War. Nevertheless, sufficient numbers of cases of thyrotoxicosis have, and are sure to occur again to make this an important problem in the medical care of enlisted men.

CLASSIFICATION OF CASES

For clinical purposes cases of thyrotoxicosis (exophthalmic goiter, Graves disease, Basedow's disease, primary hyperthyroidism) had best be divided into the following groups:

1. Classical cases of exophthalmic goiter showing all the cardinal symptoms of thyrotoxicosis, exophthalmos, rapid pulse, irritability and nervousness, swelling of the thyroid and loss of weight.

Although the severity of the illness may be of all grades, the great majority are more commonly of the severer type. The

clinical manifestations are well marked; the basal metabolic rate is relatively high; diarrhea and loss of weight are frequently present; and the patients sometimes run high temperatures. Adequate preparation of the patient for subtotal thyroidectomy is commonly difficult. Operation carries with it, usually, a great degree of risk, and many of the fatalities fall into this group. Recurrences are very apt to follow.

2. Cases of thyrotoxicosis in which the cardinal symptoms are present with the exception of exophthalmos: Although here also all grades of severity can be found, usually the clinical disturbance is relatively mild. With the exception of exophthalmos the symptoms are distinct. The basal metabolic rate is commonly not very high. The preparation of the patient for operation is relatively easy; operation is not attended with any excessive degree of danger frequently present in the exophthalmic group; patients make a good recovery and the recovery is usually permanent.

3. Cases falling into any of the preceding two groups, but in which psychotic symptoms of one kind or another—usually of the excitatory type—form the chief subjective symptom for which the patient seeks relief. The cardinal symptoms of thyrotoxicosis are present and elicitable, but they seem to be without their usual emphasis. They are relatively mild in most of the instances. In some of the cases, the symptomatology is of such a nature that the underlying condition is not recognized as a form of thyrotoxicosis until an increase in the basal metabolic rate is discovered. The latter is usually relatively low, very rarely over 40 or 50. It will fall appreciably with ordinary therapeutic measures without the exhibition of iodine. Preparation for operation is somewhat disturbed by the mental disposition of the patient; but, nevertheless, it is relatively easy to accomplish. Operation is not accompanied by any untoward risk. Residual symptoms, as will be further elaborated, subsequently always include those related to the mental state.

4. Cases of localized adenoma of the thyroid with symptoms of mild hyperthyroidism: The patients are not very ill; the symptoms are not very marked; the basal metabolic rate is only mildly elevated; preparation for operation is very easily accomplished; operation carries a minimum of risk; good recoveries are made and the latter are permanent. Subsequently, these patients do not carry any potentiality for recurrences of symptoms unless new adenomas develop.

GENERAL THERAPEUTIC CONSIDERATIONS— INTOLERANCE FOR HEAT

Because of their increased metabolism, tolerance for heat is decreased in patients with thyrotoxicosis. The body surface is warm, moist and frequently erythematous. Sweating is a common symptom. The patients require less bedclothes to be comfortable, lighter garments and lower room temperatures. It is notorious how severe postoperative febrile reactions are, and how badly these patients behave generally, when operation is done in the hot periods of our summer months; and some patients are lost under such circumstances from hyperthermia every year. This is a very important item in the make-up of these patients.

For this reason, and because in army life it is relatively easy to accomplish, all patients with any form of thyrotoxicosis, and especially those with exophthalmic goiter should be segregated to hospital centers on our northern, eastern and western seaboard where the heat never becomes excessive. The patients should never be sent to hospitals in our southern, middle and middle eastern areas where, during the summer, the temperatures and humidity are high. This is a most important point. Because of the large number of medical officers drawn from civilian life, the care of these patients should be entrusted to specialists who have had adequate training and experience in the handling of this disease.

COMPLICATING FACTORS

There are two important complicating factors: (1) valvular or myocardial heart disease, and (2) diabetes.

Thyrotoxic patients with heart disease (thyrocardiacs) should be well prepared for the ordeal of subtotal thyroidectomy by the usual well tried physical and medicinal means. The preparation for operation should proceed along the preliminary régime outlined elsewhere in this communication until the heart condition is put in as favorable a condition as is possible. There should be no hurry about this. The final preparation for operation should be begun when this is accomplished.

Diabetes is a rather infrequent complication. With our modern means of combating this disorder, it should give no great cause for alarm.

TREATMENT

Preoperative Preparation for Subtotal Thyroidectomy. No matter in which group the cases fall, the proper preoperative preparation is of paramount importance if success is to follow. Good results after operation and the degree of cure correspond completely and accurately to the thoroughness with which this is carried out, and with the degree of co-operation shown by the patient and by his family. The latter item is very much more important in this disease than is customarily understood because the very nature of the illness contributes an obstinacy of spirit and action which is not often seen in other diseases.

The object of all of this preparation is to reduce the toxicity of the disease to a state in which operation will not be attended with any excessive amount of risk, because it is found that when the toxicity of the manifestations are marked, operation is unduly dangerous and is followed by an excessive mortality. The prevailing guides upon which this judgment is made is based on the nervous symptoms exhibited, the pulse rate, the basal metabolic rate and the gain in weight. When the preparation has been adequate, the ner-

vousness of the patient is very much diminished, the pulse rate falls to less than 100 per minute, the patient stops losing weight and begins to gain and the basal metabolic rate falls to a low level, usually under 25. Practically speaking, one puts the patient through a course of medical treatment and tries to obtain as much of a medical cure as is possible.

The following régime for the preoperative preparation has been found to yield superior results:

1. *Rest in bed under hospital conditions.* It is not possible in the greatest number of the cases to prepare a patient properly at home. In the hospital the patient is under his physician's absolute control and all kinds of disturbances can be eliminated. These include absence from business and from business worries, no visitors and no other patients in the same room. Usually this is a complete test of the patient's and his family's willingness to co-operate.

2. *A high caloric diet, never less than 3,500 calories per day.* The patient may rebel against this after a few days, so that it is necessary to make sure that he takes the full amount of diet ordered. The patient should be weighed frequently—at least twice each week—to guard against any loss of weight.

3. *Plenty of sedation* is required given (a) in the form of medication and (b) by physical means.

Phenobarbital given in such dosage as to make the patient sleepy a good part of the twenty-four hours is preferred. Hydrotherapy in the form of the Priesnitz pack, given two or three times daily, is an excellent adjuvant sedative measure. The patient is wrapped in an old sheet, wrung out of water at a temperature of 60°F., and then covered with a second blanket. If one of the doses of the phenobarbital is given about fifteen or twenty minutes before the pack, the patient very commonly falls asleep in the pack and that is a very desirable feature. Occasionally the pack must be omitted because the patient is refractory toward it.

4. *The basal metabolic rate should be determined once each week* as, besides the clinical aspects, this gives a very reliable index of the improvement which has taken place.

5. *In the usual run of case, iodine had best not be administered* until the effect of the preliminary treatment has become apparent. Maximum preliminary benefit is obtained in from two to three weeks and is recognizable both by an amelioration in the general clinical picture and in an appreciable fall in the basal metabolic rate. At this stage and only at this stage, iodine in the form of Lugol's solution should be administered. The dosage should be adequate, not less than ten minims three times each day and sometimes somewhat more. When the patient responds adequately, a further betterment of the subjective symptomatology and a further fall in the basal metabolic rate occurs. Commonly the patient at this stage feels, acts and looks very well.

Therapeutic Effect of the Preliminary Preparation. The effect of all of this preliminary treatment will be one of three: (1) The cases which respond readily and quickly. These are the milder type of case, commonly in the group without exophthalmos and less frequently in the group with exophthalmos. The basal metabolic rate falls to a low level, 25 or less, the patient stands operation well and no untoward incidents occur. (2) The cases in which a moderate amount of difficulty is present, chiefly in that the basal metabolic rate falls very slowly or not to the low level to which we should like it to fall. These cases should be watched more carefully, the régime should be carried out more slowly and for a longer period. Usually our object is accomplished. (3) The cases in which marked difficulty in preparation is present. The difficulty is clinically apparent in that the patient's symptomatology does not improve, there is a persistent loss of weight, and the basal metabolic rate remains at a high level and does not fall.

Under such conditions the preliminary treatment without Lugol's solution should be persisted in for a much longer time. Only then, when all the possibilities of this are exhausted, should Lugol's solution be given. Rarely a dramatic response occurs; the symptoms improve and the basal metabolic rate quickly falls to the desired low level; or no improvement follows. The latter form the group of most difficult cases to manage and the difficulty sometimes is insuperable. If Lugol's solution produces no effect within twelve or fourteen days, the chances are that no further good will be accomplished by it as the patients have the tendency to become iodine fast.

This tendency is a very important and common item in the make-up of hyperthyroidism. It is important to remember that as far as possible iodine should not be administered until one is of the opinion, first, that all the possible good has been accomplished by the preceding preliminary treatment, and, second, that the patient is about ready for the final preparation for operation. Then the iodine should be given in adequate dosage for a period not exceeding twelve days and the patient should be operated upon immediately. If operation is not done at this most opportune moment, it commonly happens that the good effect of the iodine as a preparatory measure for operation is lost (i.e., the patient becomes "iodine fast") and operation done subsequently is done at an increased risk.

Operative Treatment. Operation is the final stage of the active treatment. Satisfactory results are obtained only by removal of an adequate amount of thyroid tissue, i.e., by subtotal (bilateral) thyroidectomy. Other operative procedures such as pole ligation or any unilateral operations can be considered only as preliminary procedures for the former. These are commonly referred to as stage operations.

It is my firm opinion that when a patient is so sick that stage operations must be

considered, he is not ready for any operation, either because of the severity of the illness or because he has been badly or insufficiently prepared. When a patient with thyrotoxicosis has been well prepared, a complete operation can be done in one sitting with no more risk than with a partial or stage operation. As a matter of fact, when the stage operation must be considered, it is my experience that the latter, even a unilateral pole ligation, carries infinitely more risk than a complete subtotal thyroidectomy on a patient well and adequately prepared. It is always my hope that patients will come at an early stage of their illness and before iodine has been given. Then with any kind of co-operation on the part of the patient and the patient's family, preparation can always be done properly and adequately. Then, too, I am always able to do the entire operation at one sitting with as little risk as possible.

An important point to remember is that neither the patient nor the family know when the operation is to be done so that no undue nervous tension is provoked. The patient is put through a sham immediate preparation for operation so that when the time comes, the true final preparation can be carried out without awakening any suspicion that operation is about to be done. This is very important.

For this reason, also, avertin given by rectum is the anesthetic and anesthesia of choice. The nurse gives this to the patient as she customarily does an ordinary enema and the patient falls asleep calmly without any rise of pulse rate. This is done in the patient's room, and the anesthetist and the operating room environment is not visible to the patient.

The steps of the operation are well known and need no repetition here. Suffice it to say that only a small strip of thyroid tissue at the posterior border of the gland on either side is left with a small segment of the upper pole. The raw area of thyroid tissue is closed by suture. Proper precautions are of course necessary that neither

the recurrent nerves nor the parathyroid glands are injured or removed accidentally. I usually drain either side of the neck with a small tube for twenty-four or forty-eight hours. This does not interfere with healing and the wounds are usually entirely healed by the end of the week.

Lugol's solution is continued in the immediate postoperative period and in decreasing doses later and for several months. Hyperpyrexia sometimes occurs within the first few days after operation and is treated by cold packs and aspirin to reduce the temperature, and by intravenous glucose and Lugol's solution to decrease any toxicity. Typical thyroid crises are seen very rarely when the patient has been well prepared.

The convalescence should not be hurried. It usually takes several months before the full benefit of subtotal thyroidectomy is obtained. And the patient should be kept under follow-up observation for a long time.

APPRAISAL OF RESULTS

In the great majority of the cases, the régime outlined in this paper will be followed by a more or less complete subjective cure. Nevertheless, in the great majority of instances, most of the demonstrable preceding objective symptoms, such as exophthalmos and tremor, can be demonstrated postoperatively to some degree. There also continues some of the underlying potentiality for nervous disturbances which should be taken as a warning that, even if the patient is apparently subjectively cured, any undue and extraordinary stimulus can cause a recurrence of symptoms. For this reason a searching inquiry into the possible causative factors which produced the illness originally should be made with the object of eliminating this from the patient's life. In this regard, the home and business influence and atmosphere is of paramount importance.

In observing the patient after operation, the determination of the basal metabolic rate should not be made for at least one

month after discharge of the patient from the hospital. It is preferable that this should fall to slightly below normal.

Recurrences of symptoms occur in a small proportion of the cases—probably 10 to 15 per cent. These recurrences are based upon physical changes associated (1) with an insufficient removal of thyroid gland substances, and/or (2) with a hyperplasia and/or hypertrophy of the part of the gland left; or they are based upon undemonstrable biological chemical changes, either in the part of the gland left or in other glands of the endocrine system, notably the pituitary. Not always is there any increase in the basal metabolic rate; although there are cases, especially when there is enlargement of the stump of the gland, in which the metabolic rate can rise to a height comparable to that preceding operation.

When a full blown recurrence of symptoms occurs, the patient should be put through a course exactly similar to that preceding the first operation and should then be re-operated upon and any excess of thyroid gland tissue should be removed. Sometimes the amount of residual thyroid tissue after subtotal thyroidectomy is small, but it has happened in my experience that the removal of even such small amounts has given good secondary results.

In other cases we are left with the therapeutic use of Lugol's solution with or without the use of radiotherapy. These are most difficult cases to handle and not always does success follow our efforts.

The most difficult group are those in whom, preceding the primary operation, the symptomatology had included outstanding psychotic symptoms. In all of my experience I have never seen one case in which these psychotic symptoms have disappeared completely. It sometimes happens that they are slightly lessened for a very short period but then they always have recurred. Good psychiatric treatment is indicated but the outlook for the disappearance of the psychotic symptoms is very poor.

SIMPLIFIED ASEPTIC GASTROJEJUNAL ANASTOMOSIS USING THE RANKIN CLAMP*

H. P. TOTTEN, M.D.

Assistant Clinical Professor of Surgery, College of Medical Evangelists

LOS ANGELES, CALIFORNIA

IN this paper only that phase of technic in gastric resection will be considered which is concerned with restoration of gastrointestinal continuity.

minimal contamination and for practical purposes is aseptic. Relative asepsis is particularly desired in cases of malignancy.

Hemostasis. It has been found in the

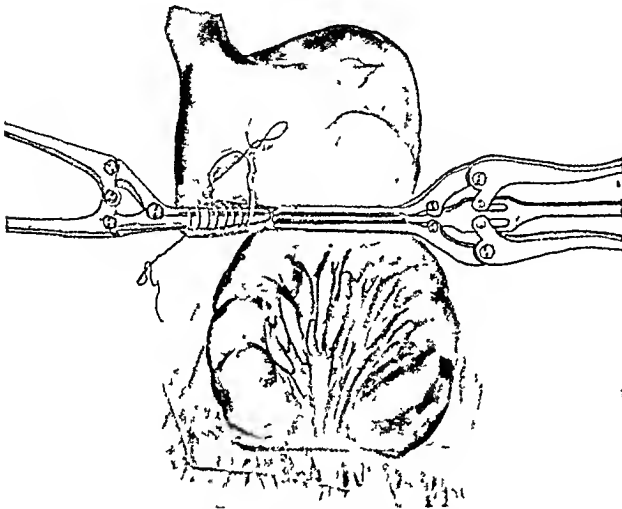


FIG. 1. Shows Rankin clamp applied transversely across stomach from the greater curvature side. Jejunum wall is held in opposite half of clamp with distal loop at the greater curvature. Right angle continuous suture is shown placed over Payr clamp which has been placed from the lesser curvature side with the tip approximating the tip of Rankin clamp.

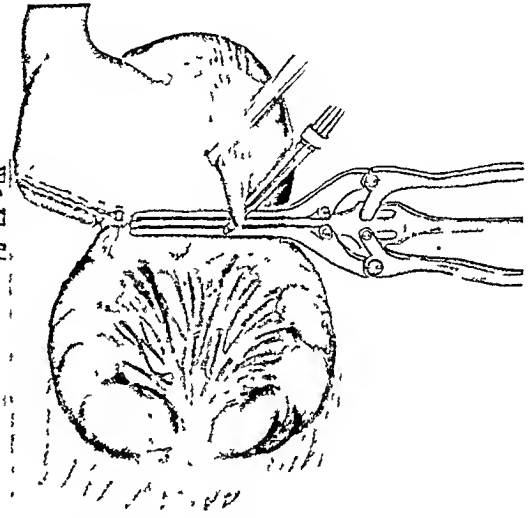


FIG. 2. Shows Payr clamp removed and crushed tissue has been inverted by right angle continuous suture reinforced by a second layer of interrupted mattress sutures. Strip of jejunum projecting above clamp is removed by cautery leaving, however, a narrow cuff of tissue attached to the clamp for cauterizing in order to effect complete hemostasis.

The application of the principle of aseptic anastomosis following resection of the stomach possesses definite merit provided simplicity of procedure is maintained. In considering the relative merit of closed as compared with open anastomosis the following factors should be considered:

Relative Asepsis. An open anastomosis even though carefully performed is inherently not an aseptic procedure. The so-called aseptic anastomosis performed over crushing clamps gives by comparison

experimental laboratory and in clinical use that the hemostatic effect obtained by crushing the stomach and jejunal wall with the Rankin and Payr clamps is entirely adequate to seal the vessels and avoid post-operative bleeding provided the suggestion of Hollman is followed of leaving a narrow cuff of tissue distal to the clamp which is cauterized to insure hemostasis. Several experimental anastomoses were performed without the use of the cautery until one fatality occurred because of obstruction at the stoma, the result of an adherent clot

* From the Department of Surgery, College of Medical Evangelists.

at the anastomotic site. This incident emphasized the possible hazard of even a small amount of bleeding and the importance of strict hemostasis.

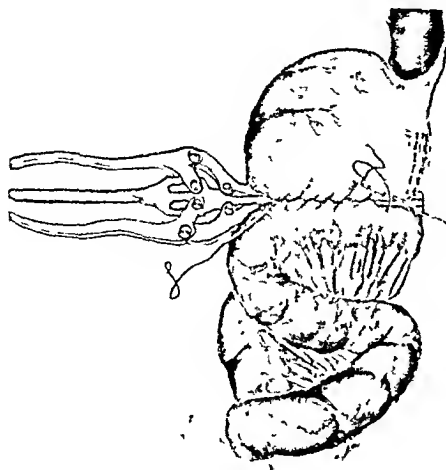


FIG. 3. Shows posterior surface of stomach and adjacent jejunum after rotation of Rankin clamp through an arc of 180 degrees. The right angle continuous approximating suture is shown partially completed. Note that stomach and jejunal wall fall together closely approximated which enables continuous approximating sutures to be placed without tension.

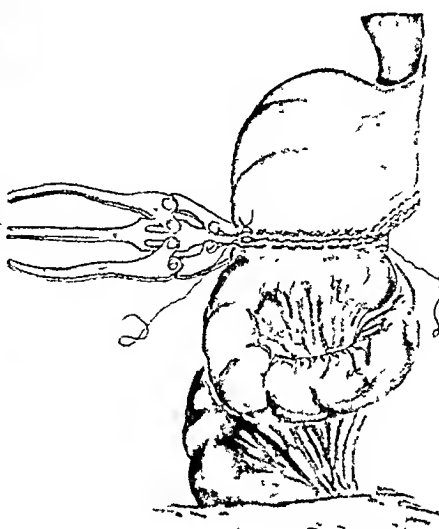


FIG. 4. Shows layer of interrupted mattress sutures placed to reinforce right angle continuous suture; posterior wall of stomach still presenting. Note ends of continuous suture left long.

Continuity of Tissues at the Gastrojejunal Stoma. Anastomosis over crushing clamps obtains adequate seroserous apposition with rapid re-establishment of continuity of the mucosal surface following sloughing of the crushed tissue. This restoration is fairly complete within a period of seven to fourteen days after anastomosis.

The Amount of Tissue Held in the Anastomotic Clamp Which Is Not Available for Resection. The amount of stomach tissue held in the rubber shod clamp in the usual open anastomosis and consequently not available for removal is not inconsiderable. In case of the crushing clamp it is minimal. Stomach and jejunal tissue is traumatized by rubber shod clamps used in an open anastomosis while this is obviated when crushing clamps are used as the tissue held within the grasp of the clamp sloughs.

TECHNIC

For optimum functioning of the newly formed gastroenteric stoma it is advisable to section the stomach transversely to the

long axis of the body. This should obviate the necessity for an anastomosis between the proximal and distal jejunal loops. The Rankin clamp is applied to the gastric wall from the greater curvature side at the level to be resected. A small Payr clamp grasps the stomach from the lesser curvature side, the tip of which approximates the tip of the Rankin clamp. A long Payr clamp is placed distal to these two clamps and the stomach sectioned between with cautery leaving a narrow cuff on the proximal side. In case of an ulcer high on the lesser curvature the small Payr clamp may be applied with its base at the tip of the Rankin clamp and its tip at the lesser curvature. As an antecolic anastomosis is to be performed the opposite half of the clamp is applied to the anti-mesenteric border of the jejunum at a distance approximately 18 to 20 inches from the ligament of Trietz. Included within the grasp of the clamp should be a sufficient length of jejunum to oppose that portion of adjacent stomach wall within the grasp of

the opposite half of the clamp and only a sufficient depth to provide adequate jejunal opening for the stoma. In order to facilitate the placement of the jejunal wall within the grasp of the clamp two traction sutures or Allis forceps are placed on the antimesenteric border, to act as a guide at a distance equal to the length of bowel to be included. A right angle continuous suture of chromic catgut (No. 1 or 0) is placed over the Payr clamp. After removal of the clamp the suture is pulled taut, thus inverting the crushed tissue with approximation of serosa to serosa. This layer is reinforced with interrupted Halsted mattress sutures of Pagenstecher linen. The Rankin clamp is then rotated through 180 degrees vertical which presents the posterior surface of the stomach and adjacent jejunum in close proximity. A continuous right angle suture of chromic catgut No. 0 with an occasional back stitch, for the purpose of locking, is now placed which snugly and completely approximates, without tension, stomach to jejunum. A reinforcing layer of interrupted mattress sutures is now placed. The clamp

applied over the clamp which is then removed and the suture is drawn taut, inverting the crushed tissue and approxi-

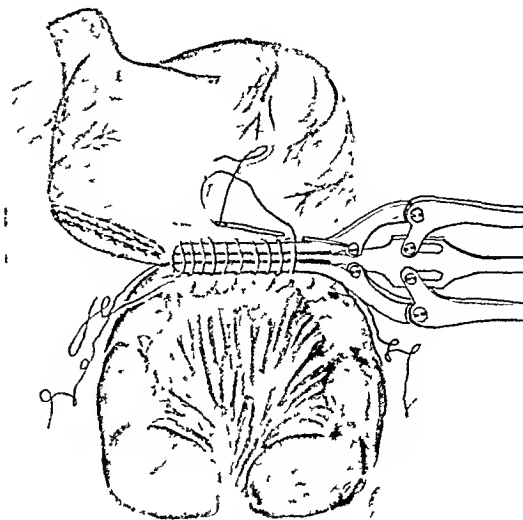


FIG. 5. Shows anterior surface of stomach presenting after rerotation of clamp. Right angle continuous suture has been placed over clamp.

mating serosal surfaces of stomach to jejunum. The ends of this suture are tied to the ends of the posterior continuous

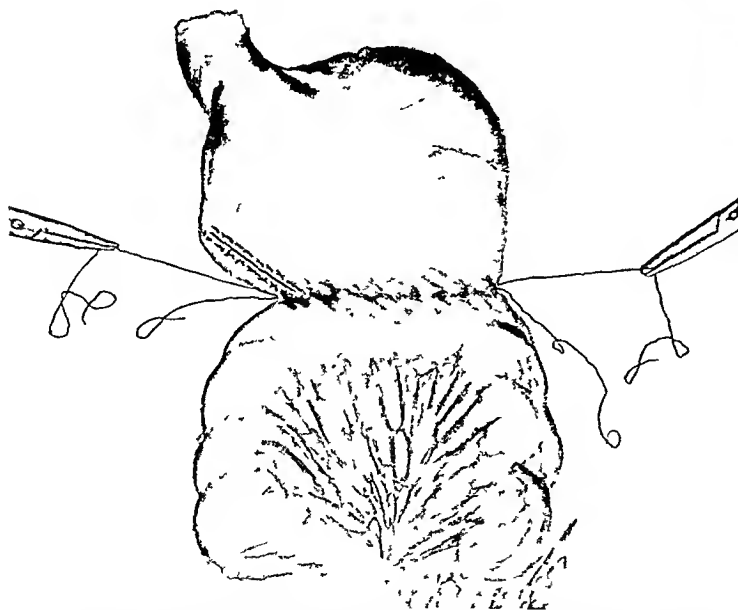


FIG. 6. Clamp removed and suture drawn taut inverting crushed tissue and approximating serous surface of stomach to serous surface of jejunum.

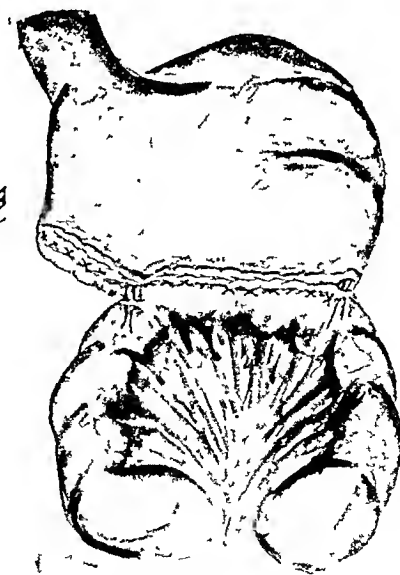


FIG. 7. Shows reinforcing layer of interrupted mattress sutures.

is then rerotated so that the anterior surface of the stomach presents. A right angle continuous suture of chromic catgut is

suture, cut short and inverted with mattress sutures. The anterior suture line is now reinforced with a layer of interrupted

mattress sutures and the proximal jejunal loop may be approximated with interrupted sutures to the suture line extending to the lesser curvature. At each extremity of the stomach jejunal approximation reinforcing sutures may be placed, over which are tied a portion of omentum.

COMMENT

The Rankin clamp is considered well adapted to gastrojejunal anastomosis. The length of the crushing blades is sufficient to create an adequate gastrojejunal stoma, the crushing power of the clamp is adequate for hemostasis and the tissues to be sutured are held stabilized by the clamp in a favorable position for accurate suturing. Of special advantage is the fact that rotation of the clamp through a vertical arc

of 180 degrees presents in an anterior position the posterior surface of the stomach and adjacent jejunal wall which lay opposed in such a manner that two rows of sutures may be placed on the posterior aspect of the anastomosis without tension in this accessible anterior position. After removal of the clamp, only the outer anterior layer of interrupted sutures needs to be placed for completion of the anastomosis. The fact that all except a small portion of the anastomosis can be completed with the clamp in place is advantageous because its stabilizing effect facilitates the placement of sutures.

REFERENCE

1. HOLMAN, EMILE. *Surg., Gynec. & Obst.*, 74: 146-152, 1942.



TUBERCULOUS CERVICAL ADENITIS

TREATMENT BY IMMOBILIZATION

W. GRANT WAUGH, M.D.

Honorary Orthopedic Surgeon, The Memorial Hospital, Darlington; Honorary Assistant Surgeon, The Royal Infirmary, Sunderland

SUNDERLAND, ENGLAND

DIMINUTION or arrest of the functional activity of an infected organ constitutes a cardinal principle in the treatment of tuberculosis. As such, it was established in the treatment of surgical tuberculosis early in the present century, and became applied successively to the hip, knee, ankle and elbow joints, to the joints of the vertebral column, by the use of plaster or other forms of splinting, and more recently by extra articular bone grafting; and reached its apotheosis in the induction of artificial pneumothorax and thoracoplasty in the treatment of pulmonary tuberculosis. Splinting of the neck has been advised as after-treatment following operation (Rose and Carless), and Calvé noted that in cases of Pott's disease of the cervical spine any associated glandular enlargement subsided as recovery of the bone infection progressed under plaster immobilization. However, so far as I can discover immobilization as a therapeutic measure *per se* has not been applied in the treatment of tuberculous glands of the neck.

In the following twenty-one examples, which comprise all the cases of this condition which have come under my care during the period, immobilization has been the essential feature of treatment. Where the enlargement was solid, i.e., due to caseation without liquefaction (eight cases), fixation by plaster alone was employed; where fluctuation was present but the skin remained healthy (three cases) the fixation was preceded by aspiration; where the skin was red and obviously infected, or where a discharging sinus was present, excision of the skin, curettage of the bed and closure by fine silk sutures with

elimination of any pocket by deep suturing were employed, followed by the plaster cast. In every case, the glandular enlargement had disappeared at the close of the period noted and so far no recurrence has been found. In two cases of superficial tuberculous ulceration in the scar a few exposures to x-ray were required to complete healing. I can confirm Hamilton Bailey's comment that after a few weeks a large granulation area contracts down to a linear scar when immobilization of the neck is employed. Several of my sinus cases are left with a scar which is only discernible on close examination.

The method of applying the plaster case is as follows: The head having been washed with weak perchloride solution to remove dandruff, a pattrass of Gamgee tissue is cut to fit over the vertex and occiput, passing behind the ears. This is carried down to two inches below the nipple in front and to a corresponding level on the back. Laterally it stops short of the acromion process. A separate piece of Gamgee encircles the neck, protruding slightly beyond the chin with a square of jaconet below the mouth. A plaster case (Cellona) is cut in the dry of the same dimensions and shape as the pattrass, and a slab of six inch wide plaster bandage for the neck. The Gamgee is now tacked into position by a few stitches and the plaster case applied, special care being taken to build it up on the sides of the neck and under the chin. A few turns of plaster bandage are taken round the neck to consolidate this region. The axillae are left free so that movements of the arms are unimpeded, but the lower borders of the cast are held by a band of adhesive strap-

ping passed round the body. It is not necessary to use plaster for this purpose. The whole cast in white plaster has something of the appearance of the conventional

surprising how little discomfort is complained of. After twenty-four hours movement of the jaw becomes sufficiently free to allow of mastication. If, however, the

TABLE I
CASES WITHOUT SECONDARY INFECTION

Case No.	Age	Sex	Year	Duration of Condition	Site and Size of Swelling	Period of Immobilization	(a) Previous Treatment (b) Preliminary Treatment	Year of Re-examination	Comment
1	30	F	1936	7 months	Anterior triangle; hen's egg	8 weeks	(a) Nil (b) curettage and closure	1939	Glands contained fluid pus; resulting scar not visible
3	16	F	1936	4 months	Anterior triangle; orange	14 weeks	(a) Nil (b) Tonsillectomy	1940	Serving in forces; no remaining evidence
4	9	M	1937	4 months	Posterior triangle	3 months	(a) U.V. light (b) Tonsillectomy	1940	No visible or palpable evidence
5	12	M	1937	3 months	Anterior triangle; golf ball	2 months	(a) U.V. Light 3 yrs. previously; recurrence (b) Nil	1939	No visible or palpable evidence.
7	20	F	1937	8 months	Posterior triangle chain; fluctuation; matted chain	13 weeks	(a) U.V. light and iodine injection (b) Aspiration	1940	No visible or palpable evidence. Sister of Case 6
8	17	M	1937	5 months	Anterior triangle; hen's egg	10 weeks	(a) U.V. light (b) Nil	1939	On active service 12 months
9	11	F	1937	6 months	Anterior triangle; small orange; no fluctuation	4 months	Nil	1939	No recurrence
12	5	F	1937	2 months	Anterior triangle; golf ball	10 weeks	U.V. Light	1939	No recurrence
13	7	M	1938	4 months	Anterior triangle; matted chain	14 weeks	(a) Nil (b) Aspiration	1940	Discharge persisted till 9th week
17	10	M	1938	2 months	Anterior triangle; walnut	7 weeks	(a) U.V. light (b) Nil	1939	No recurrence
18	17	F	1938	5 months	Posterior triangle; mass occupying whole space	10 weeks recurrence 3 weeks later. (b) 16 weeks.	(a) Iodine inunction (b) Nil	1941	Immobilisation discontinued too early; latest examination shows fibrous nodules only: on munition work
19	4	F	1938	6 weeks	Anterior triangle; hazel nut	7 weeks	(a) Nil (b) Nil	1939	No recurrence.

Madonna's head-dress. For the purpose of concealing the inevitable soiling, it is advantageous to dye the Gamgee (I use red ink) and to paint the plaster when dry with a color of the patient's choosing. Care should be taken to see that the head is in the mean position, neither flexed or extended, while the cast is setting. It is

cast does not fit sufficiently snugly to prevent movement of the head in all directions, the patient experiences discomfort from the first, and a fresh cast must be applied.

The first cast remains *in situ* for four weeks and is then removed for examination. A new cast follows for another

TABLE II
CASES WITH SECONDARY INFECTION

Case No.	Age	Sex	Year	Duration of condition	Site and Size of Swelling	Period of Immobilization	(a) Previous Treatment (b) Preliminary Treatment	Year of Re-examination	Comment
10	18	F	1937	11 months	Supra clavicular sinus	15 weeks	(a) Nil (b) Curettage	1941	No recurrence in neck but development of TB ankle in 1940
11	12	F	1938	2 months	Anterior triangle; abscesses with secondary infection	6 weeks	(a) Iodine inunction (b) Tonsillectomy; excision of infected skin. Curettage and closure	1940	No recurrence
15	15	M	1938	3 months	Anterior triangle sinus	11 weeks	(a) Aspiration and injection Formalin. ? (b) Curettage and closure	1940	No recurrence
14	9	M	1939	12 months	Posterior triangle r. axilla; multiple sinuses	20 weeks	(a) Nil beyond dressings (b) Curettage; abduction plaster combined with neck immobilization	1940	No evidence of activity after 14 months; child evacuated
15a	10	F	1939	5 months	Anterior triangle infected abscess	9 weeks	(a) U.V. light; (b) Curettage; Bipp closure	1941	No recurrence, scar barely visible
16	35	M	1940	18 years	Posterior triangle; three sinuses	17 weeks	(a) Many forms including sanatorium (b) curettage	1941	Holds an important munition post; sinuses have remained closed for 15 months
2	8½	F	1936	5 months	Anterior triangle and parotid area; sinuses	18 weeks	(a) Nil (b) Curettage and closure; Bipp	1939	Discharge up to 12 weeks. No evidence beyond scars, which are very inconspicuous
6	13	M	1937	?3 years	Anterior triangle; puckered sinuses	12 weeks	(a) 3 courses U.V. light (b) tonsillectomy; curettage and closure Bipp	1938	Had remained healed at last examination
20	49	F	1939 1941	at least 40 years	(1) Parotid area posterior triangle (2) Anterior triangle, multiple sinuses	(1) 11 weeks (2) 12 weeks	(a) Many forms (b) Curettage and closure (partial)	1941	Suffered all her life from discharging sinuses, which broke out with each pregnancy; parotid and anterior triangle; sinuses had remained healed for 22 months, when posterior triangle sinuses appeared: these are now healed

Cases No. 15 and 15a are brother and sister.

period of four weeks. If by that time the glandular enlargement has become reduced to a series of small nodules, a thick bandage of Unna's paste, reinforced at the sides with cardboard, is worn for three or four weeks longer, by which time only minute fibrous nodes are with difficulty palpable.

I am aware that a total of twenty-one cases is a somewhat small series on which to base a method of treatment; but I report it for the consideration of those who have

large numbers of such cases to treat, in the belief that it is founded on a sound principle, is extremely simple in application and gives at least as much prospect of success as any of the numerous methods of treatment employed up to the present.

REFERENCES

1. ROSE and CARLESS. *Manual of Surgery*, p. 236, 1908.
2. CALVE. *Traitement de Tuberculose de la Vertébré*, 1911.
3. HAMILTON BAILEY. *Surgery of Modern Warfare*. P. 679. Livingstone, 1941.



THE tomograph, an instrument by which roentgenologists can visualize and localize structures and foreign bodies in three dimensions, should be part of the equipment of every base hospital.

MANAGEMENT OF TUMORS OF THE BREAST

WITH SPECIAL EMPHASIS ON THE PROBLEM OF CANCER OF THE BREAST

G. L. ROBILLARD, M.D.,

Attending Surgeon, Brooklyn Cancer Institute

S. F. AUERBACH, M.D.

Assistant Visiting Surgeon, Brooklyn Cancer Institute

AND

A. L. SHAPIRO, M.D.

Assistant Visiting Surgeon, Brooklyn Cancer Institute

BROOKLYN, NEW YORK

CONSTITUTING as they do almost 20 per cent¹ of the diagnostic and therapeutic problems at most tumor clinics, little apology need be given for another study of mammary neoplasms. Certainly periodic revisions in the light of current advances may well serve to augment life salvage. This paper is based in part on conclusions derived from our experience at the Brooklyn Cancer Institute since 1935, during which time a total of 351 cases of carcinoma of the breast in all stages presented themselves for treatment and is derived to some extent from a "Survey of End Results in Cancer Therapy," presented by the above authors at the June, 1940, Scientific Session of the American Medical Association. It also incorporates an attempted analytical correlation and evaluation of the trends, often widely divergent, predominant in the current clinical literature on the topic.

Benign Tumors of the Breast. Before consideration of the problem of cancer of the breast proper, the present disputatious status of their very nature and therapy must be indicated. The oft-discussed causal relationship between cystic disease of the breast and cancer of the breast must be dismissed as not conclusively settled at present, as noted in recent reviews. Benign tumors of the breast constitute 31 per cent of all such tumors. The only safe management for such lesions is diagnosis by biopsy, the ideal method of biopsy being a frozen section of a completely resected tumor.

Malignant Tumors of the Breast. Cancer of the breast constitutes approximately

14 per cent of all carcinoma, a figure equalled only by cancer of the cervix and exceeded solely by carcinoma of the stomach, the latter representing some 20 per cent of the cancer problem.² Since roughly 70 per cent of true tumors of the breast are malignant, the significance of cancer of the breast, although not our chief concern at the moment, requires discussion. Authorities vary considerably in their descriptive pathological groupings, but seem to concur in the statement that malignant lesions of the breast are of predominantly ductal origin. Contributory to the conflict of classification is the fact that the histological picture may differ in various areas and at various ages of the same tumor.⁴ Closely scrutinized multiple serial sections in a given case of cancer of the breast, may, as demonstrated by Koppelman⁵ and other workers reveal areas characteristically described as scirrhous, medullary, and comedocarcinoma within a single tumor mass. The authors have had ample opportunity to corroborate this viewpoint in their own series. Consequently, therefore, we agree with Wrenn⁶ and others that aspiration biopsy is a procedure of problematical value, of inconclusive meaning when negative and not necessarily characteristic of the predominant cancer-cell type present when positive. Moreover, rather than resort to limited categories for descriptive purposes we utilize the chief pathological "nomenclatures" instead of "classifications" which best define the predominant tissue volume of the tumor under consideration.

As a further introductory keynote to the essentially unsettled nature of this phase of the problem of cancer is the fact that the therapeutic management of mammary cancer is likewise more controversial now than ever before.

Clinical Grouping of Cancer of the Breast. At the Brooklyn Cancer Institute Breast Clinic, the Steintal classification has been adopted as the most satisfactory available. It is not an accurate pathological grouping, but rather a method, based on simple diagnostic procedures such as inspection and palpation, which permits prompt disposition as to the most appropriate further management as at present established. As stressed later, the factor apparently most profoundly influencing the number of five-year arrests is the percentage of Steintal I cases treated in the series.⁹ However, the fact that palpable axillary nodes, as demonstrated by Harrington,¹⁰ of the Mayo Clinic, often prove nonmalignant must not escape consideration. About 50 per cent of these cases are found to be free of axillary cancer on microscopic examination.

Time Element in Cancer of the Breast. Even though it is an obvious fact that from the moment of its inception, the sooner a given cancer is eradicated the better the chance for cure and the smaller the opportunity for regional and distant spread, nevertheless overemphasis on the rôle of the time element must be guarded against. There has in recent years been increasingly in evidence a tendency to submit to the present mortality toll of cancer of the breast, in the hopeful expectation that the key to control of the disease lay in the not too far distant era when patients could be uniformly prevailed upon to present themselves with early minimal lesions. It cannot be too strongly emphasized that complacent acceptance of this fallacy will only detract from efforts to attack the problem of cancer of the breast along more effective and promising avenues. More general recognition instead of this pessimistic aphorism, that, "the sooner the patient with cancer of the breast seeks

medical care, the sooner she dies," will, when it is properly interpreted, serve to stimulate the onslaught with renewed vigor against this scourge. Location of the tumor¹¹ and the fact that the overwhelming majority are of a highly malignant grade¹² are illustrative factors beyond our control which are as important as delay in determining the prognosis. Intrinsic tendency of the tumor to rapid growth and generalization is a factor too little appreciated.¹³ Generally speaking, the patient with a rapidly growing early painful tumor, i.e., one with a highly malignant lesion is more apt to apply promptly for medical care than one with an indolent, slow-growing, relatively painless lump. Since a lapse of several weeks in the former case constitutes a grave threat in this more prevalent type of lesion than in the latter, wherever applicable immediate radical therapy must be instituted if we are to exact the utmost in potential life salvage from the clinical material at hand.

Controversial Claims in Therapy of Cancer of the Breast. The physician resorting to clinical literature as a guide to the proper management of a patient with cancer of the breast is confronted by a confusing array of claims and counterclaims concerning the merits of various modes of treatment, a situation hardly exclusive to this field of medicine. Errors common to the entire clinical domain are equally operative here, and a brief analysis of these factors as applicable to the problem of mammary cancer, and their contributory rôle as major underlying reasons for much of the current controversy prevalent, is herewith presented. For any given claim, a comparable conflicting claim differing by less than 5 per cent can be demonstrated. Radical surgery is the most widely reported form of therapy. Disparate results of this nature confuse the issue of what constitutes proper therapy, and are largely due to faulty statistical analysis. Differences in end results may depend on selection of cases as well as modes of treatment. For any given claim of percentage of five-

year survivals, a conflicting claim differing by less than 5 per cent has been reported in the literature. The lack of a demonstrable statistically valid advantage of any procedure over radical mastectomy indicates that it has as much to offer the patient as any other mode of treatment. Most authors conclude that radical mastectomy is the treatment of choice in cancer of the breast. Some claim that irradiation, in most instances postoperative, is beneficial, but do not proffer unassailable statistical proof.

Biometry and the Problem of Cancer of the Breast. Recent years have witnessed an increasing recognition of the significance of accurate biostatistical methods in the correct evaluation of clinical data. Clinicians, reluctant in the main because of inadequate familiarity with mathematical technics, are still somewhat too prone to rely exclusively on impressions gained from personal experience with quantitatively limited material. In due fairness, it is admissible that facility in methods of diagnosis and therapy can be gained only by extensive personal clinical experience. However, reliable conclusions as to the advantage of one proposed form of treatment over another are apt to require a greater body of data than can be amassed by the individual physician or surgeon, and consequently necessitate a pooling of clinical resources.

For a difference of 5 per cent to be statistically significant (i.e., due to specific modes of therapy rather than pure chance probability) unbiased samples of magnitudes greater than 5,000 to 7,500 in each group must be compared. In small series consistent differences exceeding 25 per cent are required to establish superiority of any given mode of treatment.²⁷

It should be noted that treatment, whether surgical or radiological, is apparently the only sampling factor of a breast-cancer series that is at present controllable to any real extent. Until the very nature of the cancer problem is solved we cannot expect to influence the remaining deter-

minants significantly. Obviously, to exact the maximum in life salvage from available material, optimum therapy must be applied.

IMPORTANT FACTORS IN RELATION TO END RESULTS

Natural Survival—The Untreated Patient. Before passing on to the consideration of results in cancer therapy, a natural yardstick, that is to say the duration of the untreated disease, must be defined. Doland²² has shown that in the series of over one hundred patients with cancer of the breast, more than 20 per cent survived five years. To demonstrate the effectiveness of therapy, the average survival period of a suitably large series must appreciably exceed forty months.³⁴

Stage of Lesion. Liljencrantz⁹ has shown that the factor most profoundly influencing the number of five-year arrests obtained in a series of mammary carcinoma is the percentage of early or Steintal I cases treated. Adopting his figures, the following comparison of statistics proves illuminating:

RELATION OF PERCENTAGE OF STEINTAL I CASES TO CLINICAL END RESULTS

Author	Total Cases	Five Year Arrests, Per Cent	Percentage Steintal I of Total Cases	Treatment
Lewis and Rienhoff	950	18	14	Radical mastectomy
Harrington	2879	29	22.5	Radical mastectomy
Bartlett	158	30	34	Radical mastectomy
Lee	217	41	42	Mastectomy plus radiation
Pfahler	343	48	35	Mastectomy plus radiation

Although at first sight these end results might be construed as due to improvement in the therapeutic approach, utilization of the few statistical criteria mentioned above establishes the fact that sampling differences alone are so great as to account for any discrepancy in outcome of the various series.

Pathology of Lesion and Radiation Sensitivity. Broders has arranged tumors of the

breast into groups, varying from relatively differentiated and less malignant to highly anaplastic and malignant. Without entering into the controversy concerning the validity of grading, its significance in relation to the specific problem of cancer of the breast assumes no great degree of importance from the author's very figures which indicate that from the outset roughly nine-tenths of cancers of the breast are highly malignant. Whatever the relationship between various grades of epitheliomas and radiation sensitivity, claims that cancers of the breast are responsively radiation-sensitive are sparse indeed. It is difficult to correlate the admitted radioresistance tumors of the breast with the radiation curability nonetheless claimed by some workers in the field. It need only be pointed out that thoroughgoing search of the voluminous literature on the subject failed to reveal up to the present any paper postulating the advantages of irradiation, whether exclusively or in combination with surgery, which abided by the elementary statistical criteria of reliability heretofore discussed.

BRODER'S CLASSIFICATION OF BREAST

		No. Cases	Per Cent Cases	Per Cent Metas- tases
Grade I. . .	. . . .	129	3.8	7.8
Grade II. . .	. . . .	427	12.7	42.9
Grade III. .	85 per cent highly malignant	1091	32.4	71.7
Grade IV. . .	Greater malignancy Higher degree of anaplasia	1721	51.1	88.3

There is no conclusive evidence to indicate greater radiation sensitivity of particular histologic types of cancer of the breast.³⁵ Grading cancer of the breast according to radiosensitivity is unreliable.³⁷

METASTASIS AND RECURRENCE

For their practical relationship to the actual curative management of cancer of the breast, metastasis and recurrences need only brief discussion. Generalized dissemination is a phase of the illness in which nothing but palliation of various

degrees of efficacy can at present be offered. Liljencrantz⁹ has emphasized a point with which we are in entire accordance: that cancer of the breast spreads more widely than other epithelial tumors. The lungs, liver, bones, regional nodes, skin, adrenals, peritoneum and brain are in roughly that order, the organs most affected.⁵⁴ Splenic and ovarian involvement are not uncommon.⁵⁵ Osseous metastases can often be symptomatically controlled for long periods by radiation therapy. The average interval between operation and recurrence is two years for most sites.³⁸ Distant metastases occur more often independently of local recurrences. Local recurrences suggest incomplete extirpation.

The curable case may be simply defined as one in which the process is confined to a removable breast and resectable avenues of extension. Blood-borne extension, is, of course, irretrievable. The supraclavicular, retrosternal, and mediastinal lymph nodes, once involved, are inaccessible. However, axillary, subscapular, subpectoral, and epigastric nodes may be extirpated in the hope, occasionally justified, that extension has not progressed beyond them. Hicken⁴⁰ has recently published mammographic studies concerning lactiferous ducts as an overlooked extension pathway for cancer of the breast. Widespread ramifications of the ductal system with frequent axillary, subpectoral, midsternal, and epigastric prolongations were traced, serving as further argument in favor of radical excision of these tumors.

In the hope that resective procedures would thereby be facilitated and consequently more thorough, with direct visualization of regional lymphatics, the authors have carried out intravital contrast staining with several vital blue dyes in a few cases prior to operation with promising results thus far. Preoperative lymphography, a novel departure to our knowledge, gives greater assurance that effective radical resection has been accomplished. On completion of current studies of the value of this technic in such procedures

as block dissections of the neck and axillary and inguinal lymphatic extirpation, this matter will be presented in detail.

TREATMENT AND END RESULTS

The following review of 351 cases seen since 1935 at the Brooklyn Cancer Institute points out the fact that our experience, in general, conforms to that reported by the majority of our co-workers. Inasmuch as a sufficiently long interval has not elapsed to speak of definite "cures" or five-year survival percentages, we have referred to those cases which are clinically free of cancer at the present writing as "controlled" cases.

The average age of the patients among the 351 treated was 52.6 years. Six males are included in the study and 345 females. In the Steintal I cases the average delay was 8.3 months. In the Steintal II cases, the average period of delay was 9.6 months. There were many reasons for the delay, the most frequent being ignorance, fear of operation, medical mismanagement, senility and sociological status.

Sixty-five per cent of the cases showed duct carcinoma; 15 per cent adenocarcinoma and 20 per cent medullary carcinoma. At the time of admission, 15 per cent of the cases were Steintal I; 50 per cent Steintal II and 35 per cent Steintal III.

Clinically, 60 per cent showed spread into the axillary glands; 20 per cent into the skin; 8 per cent into the ribs and sternum and 10 per cent into the supraclavicular glands.

On postmortem examination, the following metastases were noted: 15 per cent, pleura and lungs; 40 per cent, osseous; 30 per cent, liver and peritoneal cavity; 12 per cent, brain and skull.

Seventy cases (20 per cent) received primary therapy. Fifty-six radical mastectomies were performed with only one (less than 2 per cent) operative death; 157 cases (45 per cent) received secondary therapy; 122 cases (35 per cent) received palliative therapy. Of the 227 cases re-

ceiving treatment, 30 per cent may be considered controlled and 70 per cent unimproved.

BREAST CLINIC ROUTINE— BROOKLYN CANCER INSTITUTE

1. History and physical on special breast clinic chart. General medical history and physical.
2. Local breast findings to be entered on breast chart. Transillumination, roentgen mammography if indicated.
3. Routine hemoglobin, urine, Wassermann, blood typing (if preoperative).
4. Aspiration biopsy, if indicated, in State II or III. Localized nodularities, presumably malignant fall into Stage I, to receive only immediately preoperative frozen section biopsies.
5. Routine photograph.
6. Chest plate; skeletal radiography or mammography where indicated.
7. Radiation therapy consultation.
8. Referring physician or institution to be advised of progress of case.

OPERATIVE PROCEDURE

At Brooklyn Cancer Institute, radical mastectomy is considered the operative procedure of choice. In view of the existent controversy concerning the possible superiority of other methods of treatment, we have drawn up the following list of reasons, which pending establishment of definite evidence to the contrary, we like to consider both logical and persuasive:

Most cancers of the breast are relatively radioresistant.

The lactiferous ducts have widespread ramifications.

There are extensive pathways for lymphatic extension.

The incidence of local and axillary recurrence as a cause of death is relatively low.

Although axillary metastases influence prognosis adversely,¹⁵ 50 per cent of five-year survivals had axillary metastases.

Fifty per cent of the enlarged axillary nodes in cancer of the breast are non-malignant.¹⁰

The breast is easily removed; there is a low (2 per cent) mortality, without loss of essential function.

The potential life salvage is great, prior to distant metastases.

There is a lack of statistically valid evidence to demonstrate the superiority of other modes of therapy.

Adequate case series' totals (i.e., thousands) demonstrate that there is an advantage over the untreated group.

As pointed out by Maddock⁴² and his co-workers, the blood loss in radical mastectomy generally exceeds that of most other major surgical procedures and is particularly apt to precipitate surgical shock. We have modified the standard procedure in a few details to minimize hemorrhage, and consequent operative mortality and morbidity, as well as to ensure radical extirpation as meticulously as possible.

The surgical technics described by various authors suffer no less from lack of agreement as to optimum procedures than the foregoing aspects of breast cancer diagnosis and management. Inasmuch as no trustworthy improvement in results has been reported for any given procedure, it can be assumed that they all accomplish in effect the same thing. Since the surgical anatomy has been amply described elsewhere, we shall stress only those features which we believe to have been given inadequate attention.

Concerning the fifty-odd incisions described,⁵³ we can only point out that such surgeons as Crile⁴³ and Lewis and Rienhoff⁴⁴ are in conflict concerning the very status of so basic a principle as the proper amount of integument to be excised. The former believes wide skin excision unimportant, the latter hold that greater skin sacrifice lessens the incidence of postoperative local recurrence. We are somewhat inclined to agree with this last doctrine, and have found the Deaver incision⁴⁹ most suitable for general purposes and one that readily lends itself to necessary modification, e.g., in removal of an involved axillary mammary gland process. Proper identification and ligation of the thoraco-acromial trunk, as it perforates the costocoracoid membrane medial to the tendon of the pectoralis minor, is of

paramount importance in reducing blood loss. On retracting the pectoral muscles and tensing their slips of origin, we place clamps tangentially, close to the chest wall, before severing the interdigitations and in this way avoid the danger of having a bleeding vessel retract intercostally. In a random dozen operative descriptions, half the authors are found to complete the axillary dissection first,^{45,49,50,51,11} while the remainder,^{46,47,48,19,52,3} postpone this until the pectoral muscles have been severed. Since no anatomical fascial continuity exists between the epigastric portion of the rectus sheath, which we resect routinely, and the prolongations of the axillary fascia to the coracobrachialis muscle and brachial plexus, we make it a practice to remove the breast and underlying pectoral muscles *en masse* in a caudal and medial direction, to minimize surgical dissemination of malignant cells, and return to complete the axillary dissection as a secondary procedure. Unless cancerous involvement counterdicts, the cephalic vein, subscapular nerves and vessels, and long thoracic nerve are preserved intact. The causal relationship of any step in the operative procedure to postoperative edema, is, to our minds, still indefinite. Where necessary, therefore, the axillary vein is sacrificed, without apparently predisposing to such edema to any greater extent. The serratus, latissimus dorsi and subscapular fascia are cleaned and the brachial plexus and artery denuded before closure. Our preference has been for electrosurgical hemostasis in the first stage of the operation, resorting to sharp dissection in the axilla. If necessary in closure, skin grafts are utilized. Careful skin approximation seems to us to hasten postoperative healing considerably, and is allowed as long an interval as this painstaking procedure requires.

SUMMARY AND CONCLUSIONS

An analytical survey of 351 cases of cancer of the breast seen at Brooklyn

Cancer Institute since 1935 is presented in conjunction with a critical evaluation of end results.

The management of cancer of the breast is more controversial at present than at any other period. The underlying factors for this state of affairs are analyzed in an attempt to arrive at an optimum routine for the treatment of operable cases.

Several technical operative features are discussed in relation to the prevention of undue hemorrhage, postoperative morbidity and recurrence.

Reported five-year survivals vary roughly from 30 to 40 per cent without statistically indisputable evidence that such differences are due to specific modes of therapy. The fact most profoundly influencing the number of five-year arrests is apparently the percentage of early or Steintal 1 cases treated in such series. Valid improvement over the 30 per cent five-year survival rate reported forty years ago after radical mastectomy alone has not been biometrically established. The essential determinants, then as now, appear to be the rate of preoperative growth and the tendency to localization or metastasis of a given cancer of the breast.

The five-year survival rate for untreated cases is about 20 per cent. However, all these survivors have active lesions. After radical amputation roughly one-third of the patients with cancer of the breast survive, demonstrating a statistically significant advantage. In reliably large series of cases the sole major determining factor for success within our control appears to be surgery.

Thirty to 40 per cent of patients with cancer of the breast are demonstrably aided by present methods of treatment. Sixty to 70 per cent are doomed to failure. The baffling intrinsic factors predicate failure in some two-thirds of all cases of cancer. In the 30 per cent which are benefited, the percentage of Steintal 1 and radical mastectomy are the major factors for success.

REFERENCES

1. Report of the New York State Legislative Cancer Survey Commission, Albany, 1939, Leg. Doc. no. 64.
2. ROBILLARD, G. L., SHAPIRO, A. L. and AUERBACH, S. F. Scientific Session, Surgical Exhibits, American Medical Association, New York, 1940.
3. BEHAN, R. J. Cancer. St. Louis, 1938. Mosby.
4. EWING, J. Neoplastic Diseases. 4th ed. Philadelphia, 1940. Saunders.
5. KOPPELMAN, H. Personal communication to the authors; work in preparation for publication.
6. WRENN, F. and FEDER, J. M. Aspiration biopsy. *Surgery*, 11: 456, 1942.
7. PACK, G. T. and LIVINGSTON, E. M. Treatment of Cancer. New York, 1940. Hoeber.
8. PACK, G. T. and LIVINGSTON.⁷
9. LILJENCANTZ, E. Cancer Handbook, 2nd ed. Stanford University Press, 1939.
10. HARRINGTON, S. W. Unilateral carcinoma of breast. *Surg., Gynec. & Obst.*, 60: 499, 1935.
11. MARSHALL, S. F. Surgical Practice of the Lahey Clinic. Philadelphia, 1941. Saunders.
12. BRODERS, A. J. In Pack and Livingston, chap. III.⁷
13. CHILKO, A. J. and QUASTLER, H. Delayed metastases in cancer of the breast. *Am. J. Surg.*, 55: 75, 1942.
14. ROBILLARD, G. L., SHAPIRO, A. L. and AUERBACH, S. F. Survey of Breast Cancer Cases at Brooklyn Cancer Institute, 1941.
15. MACDONALD, D. Mammary carcinoma. *Surg., Gynec. & Obst.*, 74: 75, 1942.
16. MACDONALD, E. J. and MACDONALD, F. Evaluation of cancer control methodology. *Am. J. Public Health*, 30: 483, 1940.
17. CHADWICK, H. D. and LOMBARD, H. L. State Cancer Program, 1928. *Am. J. Public Health*, 28: 14, 1938.
18. Quoted by GOTTESMAN, J. *Surg. Clin. North America*, 8: 421, 1928.
19. Quoted by CUTLEY, M. and BUSCHKE, F. Cancer. Philadelphia, 1938. Saunders.
20. GRACE, E. J. and MOITRIER, W., JR. Simple mastectomy with x-ray. *New York State Med. J.*, 36: 701, 1936.
21. PFAHLER, G. E. and VOSTINEZ, J. H. Technique and results of irradiation in carcinoma of the breast. *Am. J. Roentgenol.*, 33: 41, 1935.
22. DALAND, E. M. Untreated cancer of breast. *Surg., Gynec. & Obst.*, 44: 264, 1927.
23. SHORE, B. R. Carcinoma of breast. *Surg., Gynec. & Obst.*, 71: 515, 1940.
24. VEER, W. Cancer of breast. *Connecticut M. J.*, 5: 199, 1941.
25. ADAIR, F. E. Results of treatment of mammary carcinoma. *Ann. Surg.*, 95: 410, 1932.
26. GRAVES, S. C. Carcinoma of female breast. *New England J. Med.*, 225: 557, 1941.
27. cf. SWAROOP, S. Size of clinical samples. *Indiana J. Med. Research*, 27: 149, 1940.
28. SIMMONS, C. C. Cancer of the Breast. *Surg., Gynec. & Obst.*, 74: 763, 1942.
29. CAMPBELL, H. E. Statistical methods. *Surgery*, 9: 825, 1941.

30. PEARL, R. Introduction to Medical Biometry and Statistics. 3rd ed. Philadelphia, 1940. Saunders.
31. MAINLAND, D. Treatment of Clinical and Laboratory Data. London, 1938. Oliver & Boyd.
32. DAHLBERG, G. Statistical Methods for Medical and Biological Students. London, 1940. Allen & Unwin.
33. FELDMAN, W. M. Biomathematics. 2nd ed. London, 1935. Griffin.
34. Cancer, a Manual for Practitioners. Boston, 1940. Rumford Press.
35. STEWART, F. In Paek and Livingston.⁷
36. ADAIR, F. A. In Paek and Livingston.⁷
37. LENZ, M. In CHRISTOPHER, F. Textbook of Surgery. 2nd ed. Philadelphia, 1939. Saunders.
38. ROBERTS, F. Breast cancer. *Brit. J. Radiol.*, 14: 269, 1941.
39. HAYES, M. R. J. Discussion. *Brit. M. J.*, 2: 732, 1927.
40. HICKEN, N. F. Mastectomy. *Arch. Surg.*, 40: 6, 1940.
41. CARMEL, M. Personal communication to authors, unpublished material.
42. MADDOCK, W. G. and COLLIER, E. A. Water balance in surgery. *J. A. M. A.*, 108: 1, 1937.
43. CRILE, G. and GROBOV, A. Benign and malignant tumors of breast. *Surg. Clin. North America*, 15: 783, 1935.
44. LEWIS, D. and RIENHOFF, W. F. Study of results in breast operations. *Ann. Surg.*, 95: 336, 1932.
45. ENGEL, G. C. Cyclopedia of Medicine. Philadelphia, 1933. Davis.
46. BARTLETT, Quoted by Callander.⁴⁸
47. CHEATLE, G. L. In Paek and Livingston. chap. XLIV A.⁷
48. CALLANDER, C. L. Surgical Anatomy. Philadelphia, 1936. Saunders.
49. DEATLER. Quoted by Thorek.⁵²
50. CUTLER, E. C. and ZOLLINGER, R. Atlas of Surgical Operations. New York, 1939. Macmillan.
51. AUCHINCLOSS, H. In Christopher, F. Textbook of Surgery. Philadelphia, 1939. Saunders.
52. THOREK, M. Modern Surgical Technique. Philadelphia, 1938. Lippincott.
53. TREVES, N. In Paek and Livingston.⁷
54. WARREN, S. and WITLAM, E. M. The distribution of metastases in cancer of the breast. *Surg., Gynec. & Obst.*, 57: 81, 1933.
55. SAPHIR, O. and PARKER, M. L. Metastases of primary carcinoma of the breast. *Arch. Surg.*, 42: 1003, 1941.



ONE-STAGE RADICAL RESECTION OF THE RECTUM BY MODIFIED LLOYD-DAVIES TECHNIC*

HAROLD LAUFMAN, M.D.† AND RALPH BOERNE BETTMAN, M.D.
CHICAGO, ILLINOIS

ONE-STAGE radical resection of the rectum and rectosigmoid colon has become widely accepted as the procedure of choice in the treatment of carcinoma of the rectum. The margin of operability is ever widening and mortality statistics are well within a satisfactory limit for cancer surgery.

The technic most commonly employed today by surgeons throughout the world is that of Miles. This procedure has undergone certain refinements in technic both from the very wide experience of Mr. Miles himself and that of various large clinics in this country.

However, it is well known to surgeons that there are certain shortcomings to the Miles procedure in some cases, shortcomings which make the technic extremely difficult and which occasionally actually jeopardize the patient's chances. This is especially true in short, stocky, male individuals possessing a short mesosigmoid and in whom it is extremely difficult to visualize fully the dissection of the upper rectum through the laparotomy wound. Furthermore, after the sigmoid has been cut across and the proximal loop brought through the gridiron incision, it is necessary to pack the dissected specimen into the pelvis and close the pelvic peritoneum over the mass. This latter step is almost impossible in patients with a narrow pelvis, or in situations in which it is necessary to remove a considerable portion of peritoneum with the tumor.

The purpose of this communication is to recommend that the surgeon have in mind other procedures, which, if properly employed, can obviate certain of these

technical difficulties. We should like to recommend for more popular use the simultaneous one-stage perineo-abdominal resection of O. V. Lloyd-Davies as modified by us. In this procedure the dissection is carried out simultaneously through the abdominal and the perineal routes.

We have found that the simultaneous resection combines the advantages of the Miles abdominoperineal resection with those of the Gabriel perineo-abdominal resection without appreciably carrying over the disadvantages of either procedure. This feature was particularly appealing to one of us (H. L.) who was privileged to observe and assist Mr. Lloyd-Davies on several occasions in 1939.

Before describing the technic in detail, it might be advantageous to review briefly the essential steps in both the Miles and the Gabriel operations in order to emphasize the disadvantages in certain phases.

In performing the Miles one-stage abdominoperineal resection of the rectum and rectosigmoid colon, one usually enters the abdominal wall through a low left or right paramedian incision. After determining the extent of the lesion and the possible spread to the liver or other organs, the superior hemorrhoidal and a portion of the sigmoid vessels are ligated, the pelvic peritoneum is dissected laterally from the base of the mesentery, and the rectosigmoid colon is dissected downward to include sectioning of the suspensory ligaments. The sigmoid colon is then cut across between the blades of a de Martel clamp by means of electrocautery. The proximal loop is brought out through a left gridiron incision, and the specimen to be removed

* From the Department of Surgery, Michael Reese Hospital, Chicago.

† Dr. Laufman is now a Captain in the Medical Corps of the U. S. Army.

is then packed snugly into the retroperitoneal pelvic space. The peritoneal pelvic floor is then closed by suturing the previously dissected leaves of the peritoneum

its mass. This is especially undesirable since the carcinoma itself may be cut into. Furthermore it ruins the pathological specimen for study.

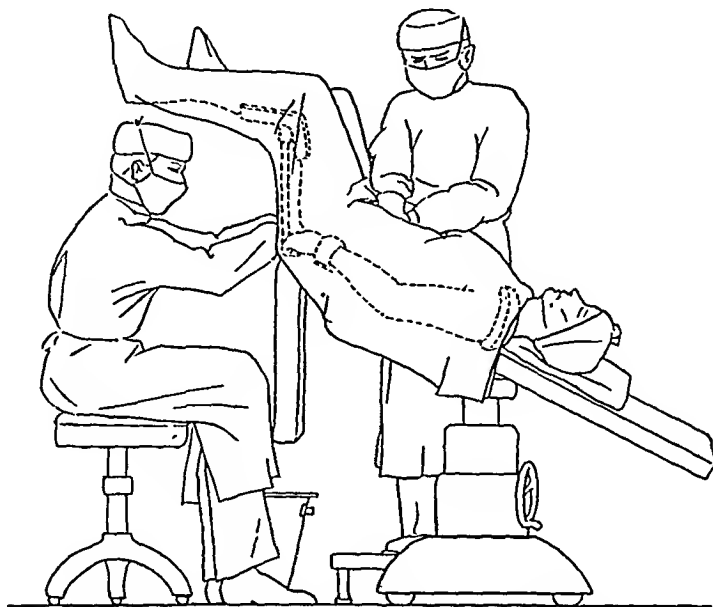


FIG. 1. Diagram of position of patient and operators in one-stage simultaneous perineo-abdominal resection of the rectum and rectosigmoid colon. Not shown are one assistant for the perineal operator and one or two assistants for the abdominal operator. For modification of the operation when only one surgeon operates, see text.

over this mass. After closing the abdominal wall the patient is turned on his side and the perineal stage of the operation is performed. This consists of disarticulating the coccyx, dissecting out the lower rectum from its surrounding structures and removing the specimen from below. The perineal defect is then lined with oiled silk and packed with gauze. Partial closure of the perineal wound is usually carried out.

As indicated above, it is difficult, indeed impossible in some cases, to acquire a satisfactory closure of the pelvic peritoneum over the pelvic space which is crowded with the specimen, even though considerable time is spent in freeing the peritoneum laterally. Extra precautions must be taken in this dissection to prevent injury to the ureters especially the left. Perineal herniation may result if this closure is not satisfactory. Occasionally, the specimen must be fragmented to reduce

It is true that the use of electrocautery and the de Martel clamp or one of its modifications have largely minimized the risks associated with cutting across the colon in the open peritoneal cavity. Nevertheless, peritonitis and wound infection are still frequent lethal factors in mortality figures following the Miles operation. It is likewise true that shock, which usually occurs in the latter stages of the operation, particularly when the patient is turned on his side for the perineal excision, is today prevented in most instances by blood transfusion, saline infusion or both. If such measures are not taken during the operation, shock is almost invariably present at the completion of the perineal phase. However, the length of the procedure in some cases will result in shock, regardless of the precautions taken.

The Gabriel one-stage peritoneo-abdominal operation overcomes the disadvantages

of the Miles procedure to some extent. Gabriel's technic consists, essentially, in first exploring the abdomen through a low right paramedian incision, temporarily closing the wound over an anchored gauze dressing, turning the patient on his side for the perineal excision, and finally completing the excision through the original abdominal incision. The perineal dissection is thus carried out first. It consists in closing the anus by two purse-string sutures and carrying out the dissection in the usual manner after disarticulation of the coccyx. The freed rectum and anus are tied firmly in a sterile glove. The peritoneum is incised from below and the rectum is pushed up into the pelvis. The perineal wound is then packed and partially closed. The patient is then replaced in the Trendelenburg position and the abdominal wound re-opened. After dividing the vascular pedicle, the entire specimen is delivered through a left gridiron incision, thus allowing the closure of the pelvic peritoneum over an *empty* pelvis. The abdominal wound is then closed and dressed. The specimen is finally removed by cautery between clamps *outside* the abdomen after all dressings are firmly in place.

It must be admitted that Gabriel has done away with several of the drawbacks encountered in the Miles operation. By doing the perineal excision early in the operation, shock is largely eliminated. By avoiding intraperitoneal section of the colon and delivering the specimen unopened and intact through the colostomy incision, the risk of peritonitis is conceivably minimized. Furthermore, it is often possible to resect a longer segment of left colon by this procedure than in the Miles operation, thus enabling the surgeon to remove a greater number of tumor-bearing lymph nodes.

Despite these apparent advantages of the Gabriel technic, there remain several distinct disadvantages. The patient must be turned at least once during the operation and sometimes twice. Moreover, it is often necessary to return to the perineal wound

to be sure of hemostasis and proper packing after the abdomen has been closed, thus necessitating either a second turn or placing the patient in the lithotomy position. Such manipulation of the position of the patient during anesthesia is known to increase surgical shock. Even in the hands of Gabriel himself, the operation is an extremely time consuming procedure. The type of patient in whom radical cancer surgery is performed, is not often a suitable risk for long, deep anesthesia, despite the great improvements in modern technic. A disadvantage common to both the Miles and Gabriel operations, is that the perineal dissection is carried out in the left lateral position. This carries with it certain limitations of good exposure and accuracy in dissection. The pelvic tissues on either side of the rectum are not placed in the same degree of stretch.

We are of the opinion that the simultaneous one-stage perineo-abdominal resection of Lloyd-Davies has certain distinct advantages over either of the above described technics in certain cases. Its advantages will be brought out as the steps in technic are described below.

TECHNIC

Anesthesia is induced with the patient lying flat on his back. After consciousness is lost, the table is tilted to a mild Trendelenburg position. The legs are then brought up and adjusted by means of stirrups or knee rests, to a mild lithotomy position. The table is broken in the usual manner for perineal procedures. The buttocks are brought well beyond the edge of the table. A small pad or sandbag is then placed under the sacrum to further elevate the coccygeal region.

Lloyd-Davies described a special type of knee rest which could be adjusted to hold the knees and legs in any desired position. However, we have found that almost any type of sturdy knee or leg support which will hold the legs separated without throwing the thighs back onto the abdomen is satisfactory. The aim in fixing

the patient's position is to allow enough room for adequate exposure from above as well as good vision and exposure from

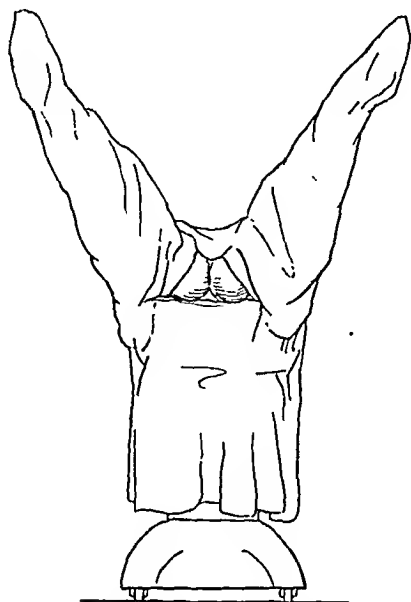


FIG. 2. Perineal view of patient, showing adequacy of exposure.

the perineal side. One must place the sacral sandbag at the point of greatest convexity of the sacrum. If the sandbag is placed too high, the pelvis will tilt away from the abdominal operator, whereas if it is placed too low, there is inadequate exposure of the coccyx. In males the penis and scrotum are kept out of the way by strapping them to the right thigh with adhesive plaster. If an indwelling catheter has been inserted, it, too, is strapped to the right thigh.

Shoulder braces are used to prevent the patient from sliding down on the table. After the position has been carefully checked for comfortable operating from both the perineal and abdominal approaches, the abdominal skin and perineal skin are simultaneously prepared with a mild antiseptic solution. The patient is then draped, allowing for a low abdominal operating field as well as an adequate perineal field. If two surgeons of experience work together, one works from the abdominal approach and the other from the perineal approach simultaneously.

The procedure, as we have carried it out, consists in first opening the abdomen in the usual manner for thorough exploration. If the lesion is found operable, the type of operative procedure to follow will depend upon the size, location and involvement of the lesion. If an abdominoperineal operation of the Miles type is decided upon, the abdominal operator carries out the usual steps as previously outlined, while the perineal operator begins the section from below. The specimen is then removed through the perineal opening as soon as it is dissected free and the bowel severed, thus allowing closure of the peritoneum over an *empty* pelvis. Furthermore, the patient need at no time be turned. The procedure, when simultaneously carried out, can be done comfortably within an hour.

If a perineo-abdominal procedure of the Gabriel type is decided upon because of a short mesosigmoid or deep attachments of the lesion in the pelvis, the perineal operator proceeds as before, while the abdominal operator ligates the vascular pedicle. After dissecting out the lower rectum the perineal operator ties a sterile glove over the closed anus for deliverance into the peritoneal cavity. In the perineo-abdominal procedure the peritoneum is best opened from below, in which case there is considerably less risk in injuring the left ureter.

Our practice has been to have the abdominal operator place a finger in the pouch of Douglas at the request of the perineal operator after the latter has reached this point in his dissection. The peritoneum is thereby easily identified, opened from below, and incised around the rectum. In this particular phase of the dissection, it is most advantageous in certain types of fixed tumors to be able to view the dissection from above as well as below.

The synchronization of both operators in dissecting this fixed portion of the rectum saves considerable time and allows for accuracy in dissection, which otherwise might not be attained. The specimen is

then brought out intact through a left gridiron incision, and closure of the pelvic peritoneum and abdominal wall are carried out as in the Gabriel technic. The specimen is removed after the abdominal dressings have been applied.

We should like to emphasize that it is not essential to have two well trained operators, provided two assistants are available. For example, the operator can transfer his position from the abdominal exposure to the perineal exposure at will, provided he carries out the accepted procedure of changing gown and gloves. This need not essentially prolong the duration of the operation.

Once the operation has been started with the patient in the above described position, whether there be one or two experienced operators, or whether the specimen is removed from above or below, certain advantages have been apparent to us:

1. The pelvic peritoneum is always closed over an *empty* pelvis.
2. The perirectal tissues are placed on a

bilaterally equal stretch for easy identification and accurate dissection from below.

3. Once the preoperative position is fixed, the patient is at no time turned or twisted into another position during the operation.

4. Full vision from both above and below makes for more accurate dissection and facilitates the removal of low lying lesions.

5. The operation can be comfortably completed in about an hour regardless of the type of dissection decided upon.

6. We believe that a more widespread use of this combined technic may broaden the field of operability still further in the treatment of carcinoma of the rectum.

REFERENCES

1. LLOYD-DAVIES, O. V. Lithotomy-Trendelenburg position for resection of rectum and lower pelvic colon. *Lancet*, 2: 74, 1939.
2. MILES, W. E. The problem of the surgical treatment of cancer of the rectum. *Am. J. Surg.*, 46: 26-39, 1939.
3. GABRIEL, W. B. Perineo-abdominal excision of the rectum in one stage. *Lancet*, 2: 69, 1934.



TECHNIC OF SAPHENOUS LIGATION

F. M. AL AKL, M.D.

Attending Surgical Staff, Kings County Hospital

BROOKLYN, NEW YORK

THE physiopathology of varicose veins and the dysfunction of the saphenous system of the leg, when its valves are congenitally defective or acquire incompetence, have for centuries been thoroughly understood. Yet it is surprising that the operation of saphenous ligation—so simple, and often so spectacular in its results—did not attain its due popularity until the last decade or two. While the operation for interrupting the saphenous backflow in order to alleviate venous stasis in the lower extremity is a comparatively simple procedure, there is, as is usually the case, a right way and a wrong way of achieving this result. The only proper surgical method is always that which, by the simplest possible maneuver and in the shortest period of time, promises the patient the maximum of benefit. The improper method is the one which consumes hours of fumbling, and after all is done, the surgeon hopes that he has not tied off the femoral artery instead of the saphenous vein, an accident, which despite its absence from the literature, has more than once taken place.

Apart from the basic knowledge of the fundamentals of surgical technic, the successful execution of this or any other operative procedure depends upon two conditions. The first condition is one of proper *geography*, the second, of positive and planned *strategy*. Obviously, a thorough knowledge of the anatomy of the region is one of the chief prerequisites of good surgery. The same object can be found more easily in one's own home than in the neighbor's home simply because there, one is more acquainted with the relations of the various objects. The object would also eventually be found at the neighbor's home but only after a great

waste of time and expenditure of energy; and in surgery, this can cause much damage.

With a lucid picture of the regional anatomy in mind, the surgeon can embark upon a preconceived, deliberate and explicit strategy of action in which the operation is divided into simple, consecutive steps to be gone over from A to Z.

As far as the geography of this particular region is concerned, the inguinal ligament which serves the surgeon so well in delineating the anatomical relations in a hernia operation, once more helps him to orient himself and become acquainted with the location and the relationships of the saphenofemoral region. The anterior superior spine of the ilium and the pubic tubercle are identified, and the inguinal ligament, hanging hammock-like between these two points is thus visualized. The midpoint of the inguinal ligament is palpated, and the femoral artery is felt pulsating at that point as it emerges from under it to course downward and medially into the thigh. Medial to the artery lies the femoral vein into the almost terminal portion of which the saphenous empties. In this connection, it is worth noting that the saphenofemoral junction is much higher than most atlases and books on anatomy picture it to be.

The long saphenous vein starts from the medial end of the dorsal venous arch of the foot and climbs upward anterior to the internal malleolus of the tibia. It continues to climb between the skin and deep fascia up the medial aspect of the leg, knee and thigh until eventually it winds anteriorly in the upper thigh, pierces the deep fascia and widens into the saphenous ampulla to empty into the femoral vein. Before it passes through the fossa ovale to empty

into the femoral vein, three tributaries empty into it; the superficial external pudendal medially, the superficial epigastric

merthiolate. The end of a damp towel folded longitudinally is pushed beneath the buttocks with a sponge holder, then

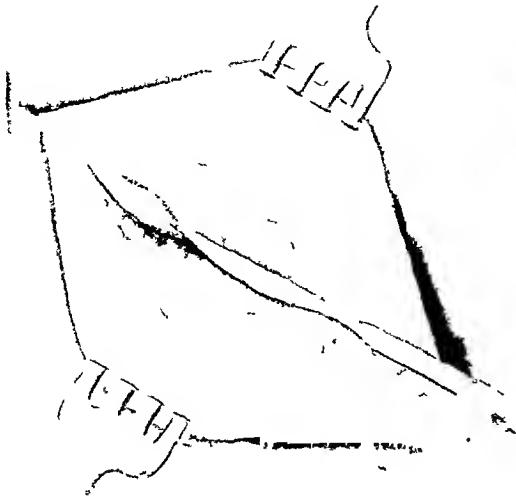


FIG. 1. Skin is separated and superficial fascia incised.

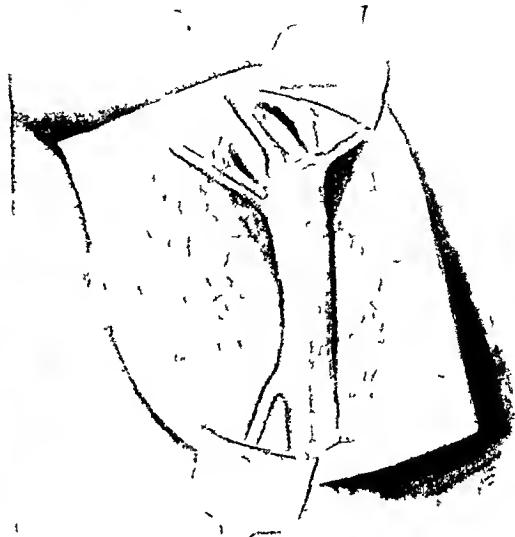


FIG. 2. Long saphenous vein exposed and tributaries isolated.

anteriorly, and the superficial circumflex iliac laterally. Any two or the entire three may join in one trunk before emptying into it. Thus the saphenous vein receives its three uppermost branches, pierces the deep fascia, widens into the saphenous ampulla and empties into the femoral vein, all within an area the size of a nickel piece. That spot is located half an inch medial and below the junction of the medial and middle thirds of the inguinal ligament.

Having acquired a clear idea of this picture with reservations for anomalies in the number and course of the vein, the surgeon is then ready to proceed with the execution of the operation.

The patient is made comfortable on the operating table with his heels placed as far apart as is convenient. In the case of obese individuals, a slight lowering of the cephalic end of the table may help to open up the inguinal fold.

The success we have had in decreasing the incidence of infection in amputation stumps by means of scrubbing the operative field with soap and water has prompted us to scrub the inguinal fold with soap and water for five minutes. The area is dried with a sterile towel and painted with

the towel is laid over the vulva or made to envelop the male genitalia and dropped on the abdomen. An upper and a lower sheet are placed across the abdomen and thighs exposing both inguinal folds, then the area is covered with a laparotomy sheet. A towel is laid over the side to be done last.

There are two technics in common use today for exposing the long saphenous vein. Some men use a longitudinal incision over the terminal portion of the vein, while others prefer a transverse incision in the upper thigh. Dr. Friedrich Trendelenburg, after whom this operation is sometimes unjustifiably named, writes this much about the technic of the operation in his article on (Ligation of the Great Saphenous Vein in Varicose Veins of the Leg), "Generally the spot at the junction of the lower and middle third of the thigh, where as a rule a dilatation is especially marked, proves to be the most favorable point for finger compression and also for ligation. Several times I have done the ligation higher up, several times in addition to the main trunk, on the dilated accessory trunk or on the lesser saphenous which was also dilated and

communicating with the greater saphenous. . . . Scarcely anything needs to be said on the technique of the operation. The

greatly simplified by means of using this incision, the resulting scar gives the best cosmetic effect as it disappears into the

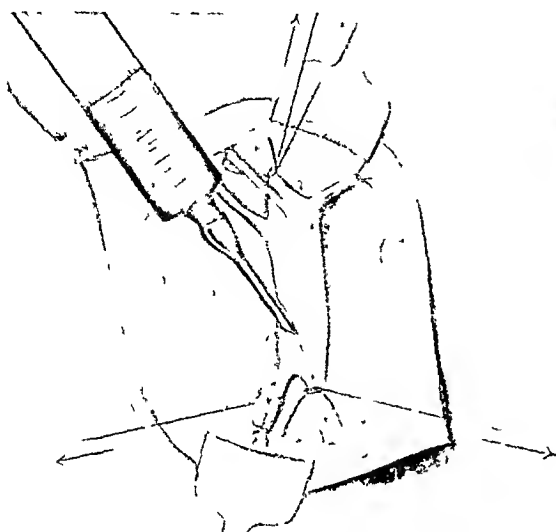


FIG. 3. Tributaries are ligated and vein is tied off distal to saphenous ampulla while sodium morrhuate is injected distally.

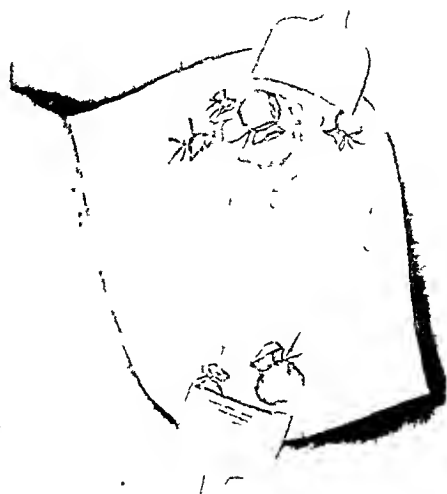


FIG. 4. Vein is resected after tying off distal end.

vein is exposed through a skin incision about three centimeters in length and isolated with the handle of the scalpel. Then the catgut suture is passed around above and below by means of an aneurysm needle, the leg raised in order to allow the blood to flow off, the vein doubly ligated and severed between the ligature, where-upon the skin incision is closed by suturing."

After years of observation and hundreds of ligations through several approaches, an incision into the medial third of the inguinal fold has proved most satisfactory for proper exposure of the saphenous vein at its junction with the femoral. This incision is superior to any other because it simplifies the technic and does away with tedious calculations that the occasional operator has to figure out before choosing the site of incision. In the big as well as the small individual, the fossa ovale is invariably exposed with this incision, and by making the incision high up in the thigh, the operator catches the vein before it had a chance to deviate either medially or laterally as would often happen when the incision is made lower down. Apart from the fact that the operation is

inguinal fold while its greater length eventually becomes covered with hair.

For anesthesia, the unreliable field block and the often unsuccessful anterior crural and obturator nerve blocks are discarded in favor of the simple, never failing local infiltration. A wide longitudinal wheel is raised with $\frac{1}{2}$ per cent novocaine over the medial third of the inguinal fold. Many a time this is all the anesthesia necessary for the entire procedure, although a supplemental infiltration of the areolar tissue down to the deep fascia is sometimes needed to complete the anesthesia. It is needless to emphasize the importance of guarding against intravenous injection of the anesthetic solution by traction upon the plunger while inserting the needle.

The incision is made into the crease of the inguinal fold. Once the skin is incised, two sharp retractors are introduced into the areolar tissue beneath the skin, the one nearest the left hand of the surgeon is held by the surgeon's left hand, the other by an assistant; and the retractors are pulled upward and apart. Traction is one of the greatest assets to the surgeon who knows how to make proper use of it.

For tissues under tension fall back when severed and retract out of the knife's way. By so doing, the chance of injuring structures unintentionally is minimized, and by pulling the severed edges apart, slicing of tissue is prevented, a factor which makes for better wound healing.

The incision is continued into the subcutaneous areolar tissue until the superficial fascia is exposed. The superficial fascia is then incised, and two small blunt retractors are used to separate the split fascia exposing the saphenous vein. If the vein exposed is not the long saphenous vein but only a tributary of it, tracing this tributary upward would invariably lead to the long saphenous. If no veins are visible upon retracting the severed edges of the superficial fascia, a curved blunt hemostat is inserted into the areolar tissue and this is opened longitudinally. The procedure is repeated until the vein is located. Once the vein is exposed, it is separated with the clamp from adjoining areolar tissue, then lifted from its bed with a plain thumb forceps while the curved clamp is passed behind it. The clamp is opened and a strand of No. 1 chromic catgut is fed into its jaw; then the clamp is closed and pulled out bringing with it the catgut strand. The two ends of the ligature are then held with the clamp and the ligature is used for traction. This maneuver, done so early in the procedure, before the vein is completely isolated from its surroundings comes in handy when, as sometimes happens while isolating the vein, a small tributary is torn and hemorrhage ensues. Traction on the ligature in such a case brings about instant hemostasis and saves the surgeon from having to work in a pool of blood or jabbing his hemostatic forceps blindly in an effort to stop the flood. After the ligature is passed around the vein, the vessel is followed upward and dissected by means of a plain thumb forceps from its anterior attachments, and with a curved hemostat from its enveloping bed. The tributaries are isolated until the saphenous ampulla is reached. The tributaries are tied off as

far away from the vein as possible with No. 0 chromic catgut. A No. 1 chromic catgut ligature is passed around the vein and tied tightly just beyond the saphenous ampulla. The ends of this ligature are held with a hemostat for traction. A loose knot is made in the original traction ligature which is now held with the two hands of the assistant and pulled gently in order to prevent bleeding from the vein after it is opened by the surgeon. The surgeon, having a 5 cc. syringe filled with 5 per cent sodium morrhuate, and fitted with a Bellevue cannula, pulls up on the upper ligature with his left hand, while the assistant pulls upon the two strands of the lower ligature each with a hand. With a curved Mayo scissors, the surgeon nicks the edge of the vein between the two ligatures, then introduces the Bellevue cannula into the lumen of the incised vein and slides its tip into the untightened knot in the distal ligature held by the assistant. The assistant tightens the ligature over the cannula once the cannula's side eye is passed beyond the ligature. The surgeon injects his sclerosing solution and withdraws the cannula. The assistant tightens the knot and completes it. The lateral superficial femoral and sometimes the medial superficial femoral are tied off if exposed in the wound, but no special effort is made to isolate and ligate them. The tributaries are then cut off and the segment of vein between the two upper ligatures and the lower one is resected. Once the cut ends of the veins are inspected for bleeding, the sutures are cut and the severed ends of the vein allowed to retract into the wound while the tissues are permitted to fall together. Bleeders are then tied off and the skin is approximated with four or five clips. The wound is smeared with petrolatum jelly and covered with cellulose film. The wound is dressed with two gauze flats, and sealed tight with waterproof adhesive straps applied fanwise from the medial aspect of the thigh to cover the inguinal creases. The clips are removed on the fifth day, and after cleaning the area is dusted with talcum powder.

RELATIONSHIP OF SUTURE MATERIAL TO HEALING IN THORACOPLASTY WOUNDS*

R. W. BUXTON, M.D.

AND

M. L. WHITE, JR., M.D.

Instructor in Surgery, University of Michigan Hospital

Assistant Professor of Surgery, University of Virginia Hospital

ANN ARBOR, MICHIGAN

CHARLOTTESVILLE, VIRGINIA

LANGSTON¹ has recently stressed the importance of the rôle of sensitivity to catgut in the healing of thoracoplasty wounds. His study of these wounds in this clinic revealed a striking difference in the healing of wounds closed with catgut and those closed with silk. However, his major premise was the allergic manifestations of catgut. Since his data were compiled, nonabsorbable suture material has been used in enough thoracoplasty operations to allow a large scale comparison of the two methods of closure. The purpose of this paper is to present a statistical study of the wound healing of 809 consecutive thoracoplasty stages performed on 195 patients from January, 1940, to January, 1942. The incisions were closed with catgut in 538 cases and with silk in 271 cases. Wound healing was studied not only in relation to the suture material used but also in relation to the method of suturing.⁴

One-half of the catgut wounds were closed with a continuous suture (which was occasionally interrupted), approximating the muscles in one layer with No. 0 or No. 00 chromic catgut. In most of the cases the subcutaneous fascia was approximated with interrupted No. 000 chromic catgut and the skin with interrupted silk. In the silk cases, each of the muscle layers was closed with interrupted No. 1 silk passed in small bites chiefly through the fascia; the subcutaneous fascia and skin were closed separately with interrupted No. 1 silk.

In the following study, all postoperative wound complications were distributed into three arbitrary groups:

GROUP A. Demonstrable fluid beneath the skin or muscles but without infection; slight skin separation with or without spontaneous escape of accumulated wound fluid, but without infection; indurated or red, "beefy" wounds which did not suppurate; small areas of skin necrosis in the suture line.

GROUP B. All subcutaneous wound infections with pyogenic organisms.

GROUP C. Submuscular or subscapular pyogenic wound infections; all tuberculous wound infections.

Of the 809 wounds studied, 121 showed complications of the above varieties, an incidence of 14.9 per cent. Not included are three wound complications obviously not related to the present study. Two of these were wound suppurations from empyema necessitatis, and one was a massive hemorrhage into the subscapular space following nine days of heparinization for a femoral embolus. Of the 538 thoracoplasty wounds closed with catgut, 102 developed wound difficulties, an incidence of 18.9 per cent. Nineteen or 7.0 per cent of the 271 wounds closed with silk had some complication.

Further analysis of the catgut wounds showed that different methods of closure had little influence upon the incidence of wound complications. Among 270 incisions closed with the continuous technic, fifty-three had complications, an incidence of 19.6 per cent. Of the 217 wounds in which an interrupted catgut closure was used, forty-four or 20.2 per cent had healing abnormalities. In fifty-one cases closed with catgut the surgeon failed to state

* From the Department of Surgery, Section of Thoracic Surgery, University of Michigan, Ann Arbor, Michigan.

the manner of closure. This group had five, or 9.8 per cent, cases of poor healing.

Table I gives a detailed analysis of the type of complications occurring with the two types of suture material and with the method of closure.

TABLE I

Suture Material	No. Stages	Group A		Group B		Group C	
		No.	Per Cent	No.	Per Cent	No.	Per Cent
Catgut Continuous.....	270	31	11.4	19	7.0	3	1.1
Catgut Interrupted.....	217	32	14.7	10	4.6	2	0.9
Catgut Unknown*	51	4	7.8	0	0	1	1.9
	538	67	12.4	29	5.3	6	1.1
Silk Interrupted.....	271	14	5.9	3	1.1	2	0.7

* Method of closure not stated by surgeon.

In the above table, Group A is worthy of special note. The great majority of cases placed in this group were those showing a red, edematous, "beefy" wound, usually with the formation of excessive wound fluid. The percentage of catgut wounds with this complication more than doubled the percentage of similar silk wounds. This is in accordance with the findings in this and other clinics which suggest that these complications may be due to catgut sensitivity. In none of these wounds did the inflammatory process proceed to frank suppuration.

Group A complications were never serious, and rarely delayed the subsequent operative stages. Groups B and C, therefore, comprise the complications which presented a threat to life or decreased the effectiveness of the thoracoplasty collapse by delaying further rib resection. Considering, therefore, the serious complications,

it was found that 6.5 per cent of the catgut wounds fell into this classification, as contrasted with only 1.8 per cent of the silk technic wounds. Serious complications occurred three and one-half times more frequently in wounds closed with absorbable sutures. In none of the 195 patients who are the object of this study did the wound infection happen to be fatal.

Effect of Apicolysis. It has been stated that in the process of extrafascial separation of the pulmonary apex, numerous lymph channels are severed. By postulation, a higher incidence of deep wound infection should follow this procedure than follows a simple thoracoplasty. An apicolysis was done or attempted in forty-six of the 166 patients receiving a primary first-stage thoracoplasty. In none of the patients upon whom secondary or revision thoracoplasties were done was an apicolysis attempted. Eight of these forty-six patients developed postoperative wound complications, an incidence of 17.4 per cent. This percentage complication, however, appears of little significance since nineteen patients developed wound difficulties among the 151 patients receiving either primary or secondary first-stage thoracoplasties without apicolysis. This is an incidence of 12.5 per cent.

TABLE II
PRIMARY FIRST-STAGE THORACOPLASTIES WITH
APICOLYSIS

Total Patients	Closure	Group A	Group B	Group C
46	Catgut	3	4	0
	Silk	1	0	0

In Table II it is notable that no deep submuscular or subscapular wound infections (Group C) appeared in this series of forty-six patients. In none of the forty-six patients, however, was an extensive apicolysis done. The extent of the extrafascial separation was never more than necessary to drop the apex to the level of the third rib posteriorly.

Effect of Formalin. The rubbing of the periosteum with 10 per cent formalin solution is the present method used in this hospital to prevent rapid stiffening of the thoracic wall by the formation of regenerated ribs between operative stages. Formalin was used on the exposed periosteal beds in 458 stages, or 56.6 per cent of the total number of operative stages. Seventy of these patients developed wound complications, an incidence of 15.2 per cent. The stages in which no formalin was used numbered 351; of these, fifty-four developed postoperative wound difficulties, an incidence of 15.3 per cent. The use of formalin cannot, therefore, be indicted in the production of wound complications.

Discussion. In reviewing the statistics of this series of 809 consecutive thoracoplasty stages, it must be remembered that the thoracoplasty wound has certain peculiar characteristics which have been pointed out by Langston. The great length of the parascapular incision, the anatomical necessity of leaving an extrapleural subscapular space which collects serum, and the reopening of the wound several times at approximately twenty-one-day intervals, all should tend to increase the incidence of healing complications. Apart from these mechanical factors, patients requiring thoracoplasty all have a certain general debilitation from their chronic tuberculosis. No attempt has been made to correlate the age, extent of disease and nutritional or vitamin balance of the patient with the postoperative wound complications that occurred. In spite of these mechanical and other factors, it is interesting to note that the percentage of infected wounds in this series, namely, 6.4 per cent with catgut closure and 1.8 per cent with silk closure, compares favorably with the percentages of infected wounds reported

in other studies. Whipple² has compiled a seven-year study with 5.7 per cent infection with the use of catgut and 2.3 per cent with the use of silk in general surgical wounds. Brown³ quotes Goff's figures of 10.0 per cent infection with catgut and 2.2 per cent with silk; Guthrie's figures of 2.9 per cent for catgut and 1.27 per cent for silk; and Longacre's figures of 15.4 per cent for catgut and 2.55 per cent for silk.

It may be added that since this study was carried out cotton has been used in our clinic with great satisfaction but there have as yet been too few wound closures with this suture material for statistical comparison of the complications.⁵

SUMMARY

The wounds of 809 consecutive thoracoplasty stages on 195 patients with pulmonary or pleural tuberculosis have been studied with relation to healing and the type of suture material used.

Minor or major complications occurred in 13.7 per cent of the wounds. The incidence was 18.9 per cent in the catgut wounds and 7.0 per cent in the silk wounds. By excluding all wound complications of a minor character and not specifically due to wound infection, the incidence was 6.5 per cent in the catgut series and 1.8 per cent in the silk series.

REFERENCES

1. LANGSTON, H. T. The problem of catgut sensitivity and its relation to wound healing. *Ann. Surg.*, 115: 141-147, 1942.
2. WHIPPLE, A. O. The essential principles in clean wound healing. *Surg., Gynec. & Obst.*, 70: 257-260, 1940.
3. BROWN, M. J. Silk and the surgical wound. *J. Iowa State Med. Soc.*, 29: 600-602, 1939.
4. SHAMBAUGH, P. Postoperative wound complications. *Surg., Gynec. & Obst.*, 64: 765-771, 1937.
5. MEADE, W. H. and LONG, C. H. The use of cotton as a suture material. *J. A. M. A.*, 117: 2140-2143, 1941.



FORESKIN ISOGRAFTS*

ALLAN E. SACHS, M.D. AND SAMUEL L. GOLDBERG, M.D.
CHICAGO, ILLINOIS

IMPROVED treatment of burns and other conditions that destroy skin has resulted in a great saving of lives. The old maxim that the prognosis was hopeless if more than 50 per cent of the skin was destroyed no longer holds. There are occasional instances of the survival of patients with such large percentages of skin denuded that the patient's remaining skin is insufficient to cover the defect, in spite of improved methods of grafting. Recently, such a patient was under our care, and we were confronted with the necessity of obtaining skin from other sources. We turned to the use of foreskins, and believe that our results are worthy of recording.

There is no unanimity of opinion regarding the success of isoplastic skin grafting. Many surgeons have been unsuccessful with this procedure. MacWilliams,¹ Graham,² Holman³ and others have stated that attempts to transplant isoplastic grafts are futile. Collier⁴ states that such grafts are lost after several weeks. Greeley⁵ thinks that grafts transferred from persons of the same blood group may take, but eventually are lost except in the cases of identical twins. Bettman⁶ has used isografts as a temporary measure and thinks they are life saving, but he states that they melt away after four to five weeks. There is general agreement that zoo grafts are entirely unsuccessful.

Several workers have reported the successful use of isoplastic skin grafts. Davis⁷ reported a large percentage of takes with such grafts. He stated that in several instances black pigmented skin was placed on white persons and the grafts became depigmented. Masson⁸ reported success but thought that the bloods of donor and recipient must match. The only report of any number of foreskin grafts is that

of Ashley.⁹ He states that a fairly large percentage of the skin remained alive, and reports that McNealy experienced similar results. Ashley was able to keep the skin on ice for several days before using it. He does not report whether all the foreskins were taken from adults or infants.

Considerable attention has been given to the question of blood groups in isoplastic skin grafts. Ashley provided no data as to the blood groups. He believes it of no significance. Shawan,¹⁰ Masson,⁸ and Kubanyi¹¹ think that only skin from persons of the same blood group can be successfully grafted. Kubanyi also thought that tissues from embryos or infants could be grafted with greater success than tissues from adult animals.

Our first experience with isografts was on a patient who had second and third degree burns which completely denuded the skin from both arms, both legs and portions of the trunk. For weeks the patient had a stormy course with daily excursions of temperature to as high as 105°F. As soon as granulating surfaces about the elbow and knee joints were fairly clean, autogenous grafts were placed, using skin from the abdomen. These were only partially successful, and the reaction from even the short anesthesia was so severe that we were not anxious to repeat the procedure. Isoplastic grafting was then begun.

Preputial grafts were used for two reasons. They were easily obtainable because of the number of ritual circumcisions performed at the hospital, and also because the authors believed that the skin of infants has greater growth potentialities than that of adults. The technic employed was quite simple. The foreskins were collected under aseptic conditions at the time of circumci-

* From the Department of Surgery, Michael Reese Hospital, Chicago.

sions. Careful examination, including serologic tests, and blood typing of the infant had been done. Later it was found that the

stimulant to epithelialization from the border of the granulation area. Epithelium crowded in toward the transplanted skin

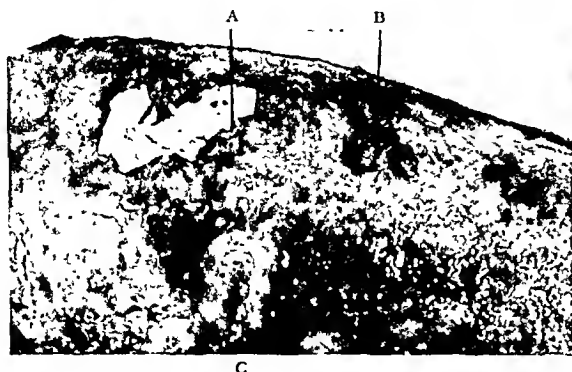


FIG. 1. Grafts of various ages in granulating surface of leg. A, twenty-four hour graft covered by silver foil. B, cyanotic graft forty-eight hours old. C, graft two weeks old with epithelium growing out from its edges.



FIG. 2. Showing leg with grafts of various ages on granulating surface. Note coalescence of grafts at A.

skins could be refrigerated in saline solution for as many as four to five days with equally good results. The mucosa was separated from the skin and the submucosal and subcuticular connective tissue was removed. The granulating wounds had been dressed with diluted Dakin's solution compresses (one-third strength). At the time of grafting the exuberant granulations were scraped off and the bleeding controlled by pressure for a short period of time. The small portions of skin or mucosa were placed over the prepared areas as pinch grafts, covered with silver foil, and the Dakin packs reapplied. The packs were kept moist with Dakin's solution and the whole area was wrapped in oiled silk. Dressings were changed daily. The silver foil prevented the grafts from coming off with the dressings. On a few occasions grafts were dislodged; they were reapplied and frequently became fixed.

The behavior of the transplanted skin differed little from autogenous pinch grafts. During the first thirty-six hours they became cyanotic. The cyanosis gradually faded and the skin became pink. (Fig. 1.) The mucosal grafts, by metaplasia of the epithelium, became cornified, resulting in formation of skin islands. The presence of the transplants of skin seemed to act as a

islands. At the same time halos of epithelium arose around the skin grafts (Figs. 1 and 2) so that denuded areas were more rapidly covered. Dressings were changed daily, and pinch grafts were placed upon the areas as needed.

Skin was first transplanted about the knees and ankles to help cover the joints and permit motion. The rest of the legs and arms were then studded with islands of transplanted skin over a period of some weeks. As the denuded areas were covered the temperature came down toward normal. The final result was excellent.

In more recent cases changes in technic have been developed. These have simplified the procedure, done away with daily dressings, and have permitted skin grafting with foreskins on ambulatory patients. The bed of granulation tissue was prepared and the grafts placed as previously described. Sulfanilamide powder was sprinkled over the surface and the whole area covered with fine mesh petrolatum gauze. On small areas adhesive strips were used to hold the grafts in place before the vaseline gauze was applied. Sterile gauze was then placed over the vaseline gauze, then several layers of soft fluffed gauze or a sea sponge was applied for pressure. This technic did not require daily dressings and

usually the dressings were not disturbed for at least five days. When the vaseline gauze was removed there was moderate amount of secretion, sometimes purulent. Despite the exudate the grafts were found to be adherent to the granulating surface in a higher percentage of instances than with the moist Dakin's pack method. As the dressings need not be moist or changed daily this treatment can be used on the out-patient who returns about every five days for changing of dressings and additional grafts. In either method the actual application of the grafts is painless since granulation tissue has practically no sensation.

Cadaver skin has been used in a similar manner as isografts. The donor skin was obtained from premature infants in whom the only cause of death was prematurity. An autopsy is performed on a very large percentage of the premature infants who die at this hospital. Before the postmortem examination was done, split skin donor grafts were removed with a razor, under aseptic precaution, within the first half hour after death. The skin was placed in sterile normal saline solution and kept in the refrigerator until the autopsy had demonstrated the cause of death. If there were no contraindications to use of the skin, it was cut into small sections about 1 cm. square and used just as the foreskins grafts. In these cases the sulfanilamide with vaseline gauze technic was used.

The results in our series of cases were most gratifying. We used about sixty foreskins, about five hundred pieces of skin and mucosa. Well over 65 per cent of the earlier group of grafts became attached and lived. About 75 per cent of the more recent grafts took. It seemed that less frequent dressings and pressure definitely increased the percentage of good results. The success of the transplants is as dependent upon cleanliness and vascularity of the recipient site as are autogenous grafts. The authors attempted transplants on relatively unclean granulation tissue and only 40 to 50 per cent of the grafts were successful. If only one-half of the

homogeneous grafts are successful, one has still aided in covering the denuded areas. The procedure can be readily repeated to



FIG. 3. Isoplastic grafts on thigh showing coalescence and epithelialization about the grafts.

compensate for the smaller number of takes. The patient does not have to be subjected to an operative procedure or anesthesia which would hardly be worth while if the recipient sites were covered with slough. Valuable time in rehabilitating the patient is thus saved.

Isoplastic grafts were also used to heal skin defects from other causes, as in varicose and trophic ulcer in which the floor of the ulcer was made up of fairly healthy granulation tissue, but the skin edges lacked the ability to cover over the defect. The presence of the island of skin seemed to act as a stimulus to the skin at the margin of the ulcer. The skin edges showed new activity and epithelium crowded in toward the grafted island.

In some cases the transplanted skin did not take, but its presence seemed to act definitely as a stimulant to the ulcer margin, greatly speeding healing. In varicose ulcers the grafts can be applied using the sulfanilamide powder method outlined and then an Unna's paste boot applied.

Another patient treated by this method had a defect following a radical mastectomy. The extent of the pathology required

such a radical removal of mammary tissue and skin that an immediate autogenous graft was done. This graft did not take

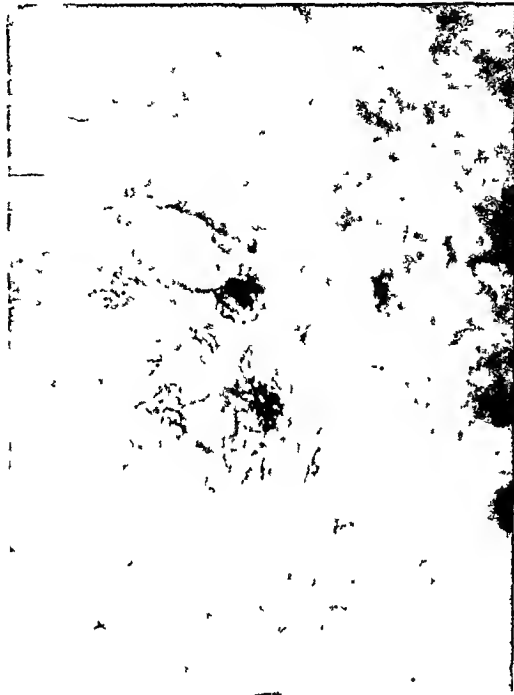


FIG. 4. Grafts on the breast near areola. These are eight months old. The area below the nipple is where a graft absorbed after about ten weeks. The surrounding tissue is thin, vascular scar epithelium

and the patient was left with a granulating defect. Foreskin grafts were used to cover the area and most of these skin grafts were placed on her after she was dismissed from the hospital.

Another patient treated as an outpatient was a boy two and a half years of age who suffered burns of both thighs involving his knees. The knees were covered with autogenous skin while he was a patient in the hospital. This enabled him to be up and walking. The thighs were then studded with islands of transplanted skin on his bi-weekly visits to the hospital. (Fig. 3.) During the weeks necessary for complete epithelialization he was able to be at home and even rode his tricycle.

In another case foreskin grafts were used to cover granulation tissue following an extensive loss of integument as a result of osteomyelitis with multiple draining

sinuses. This patient had a loss of skin over both forearms and both thighs. His course was septic when the grafts were started. Such a patient, in view of the fact that the skin had sloughed off due to infection, is not a good subject for skin grafts. However, the foreskin transplants took surprisingly well, and aided greatly in covering the granulation tissue.

SUMMARY OF FINDINGS

The authors believe that the use of skin from the newborn and premature infants is an important factor in the success of isoplastic skin transplants. The nuclei of the cells of the skin of these infants contain a higher percentage of mitotic figures than do those of the skin of adults, suggesting that growth potentialities are greater. In our experience the blood groups of the donor did not influence the survival of the grafts. It was our experience that the blood grouping of about 25 per cent of the infant donors cannot be accurately determined.

The survival of transplanted skin in this series of cases varied between 65 and 75 per cent. Even in the cases in which the transplants failed to survive the presence of the skin seemed to act as a stimulant to the patient's own epithelium and more rapid epithelialization was a result.

We know of no method of determining the length of survival of transplanted skin, but in our experience this skin, once having taken, did not melt away in several weeks as Bettman,⁶ Greeley,⁵ Collier⁴ and others described. Some grafts could be distinctly recognized eight months later. (Fig. 4.) It is impossible for us to say how long these survive, or if they are ultimately replaced. One of the cases followed over a period of two years had no loss of grafted skin with the exception of two tiny areas. (Fig. 4.) The others which were followed for shorter periods had practically no loss of skin. Several occurrences in the course of the work have given added weight to the observation that the grafts remain longer than other reports indicate. In one case a graft had not been placed on firmly and in

healing a small papilla-like crease of skin protruded. This remained without changing and finally was removed three and a half months after the graft had been applied. In one instance of transplantation of skin from a premature cadaver the lanugo hairs persisted for many weeks. In a colored patient a very small piece of white skin was transplanted to an inconspicuous area. This white skin became attached and remained.

We are emphatically not advocating this type of graft to replace other methods now in use, for obvious reasons. The end results from the cosmetic viewpoint are definitely not as good as with split thickness autogenous grafts. However, we do believe that in certain instances it is of great value as a life saving measure. The range of its use is increased by the fact that it may be used on the ambulant patient, and on surfaces that are not entirely surgically clean. The production of another open wound at the donor site,

and the use of anesthesia are obviated by this method.

REFERENCES

1. McWILLIAMS, C. A. Principles of four types of skin grafting; with an improved method of treating total avulsion of scalp. *J. A. M. A.*, 83: 183, 1934.
2. GRAHAM, E. Year Book of General Surgery, p. 50, 1935. Chicago, Ill
3. HOLMAN, E. Protein sensitization in isoskin grafting. *Surg., Gynec. & Obst.*, 38: 100, 1934.
4. COLLIER, F. A. Use of paraffin as primary dressing for skin grafts. *Surg., Gynec. & Obst.*, 41: 221, 1925.
5. GREELEY, P. W. Types of skin grafts and their individual application. *Illinois M. J.*, 75: 436, 1939.
6. BETTMAN, A. G. Homogenous Thiersch grafting as life saving measure. *Am. J. Surg.*, 39: 156, 1938.
7. DAVIS, J. D. Skin grafting at the Johns Hopkins Hospital. *Ann. Surg.*, 1: 542, 1909.
8. MASSON, J. C. Skin grafting. *J. A. M. A.*, 70: 1581, 1918.
9. ASHLEY, F. Foreskins as skin grafts. *Ann. Surg.*, 106: 252, 1937.
10. SHAWAN, H. K. Principle of blood grouping applied to skin grafting. *Am. J. M. Sc.*, 157: 503, 1919.
11. KUBANYI, A. Blood grouping as a guide in skin grafting. *Arch. klin. Chir.*, 129: 644, 1924.



SACROCOCYGEAL CYSTS

REPORT OF 200 CASES IN AN ARMY HOSPITAL

LIEUT. COL. RICHARD B. WEEKS, M.C. AND CAPTAIN GEORGE G. YOUNG, M.C.
FORT JACKSON, SOUTH CAROLINA

THE officers connected with the Surgical Service of this Station Hospital, were greatly interested in the report rendered by Lt. Col. William J. Pickett, M.C., and 1st Lt. Arch J. Beatty, M.C., which appeared in the May, 1942, issue of the *American Journal of Surgery*. This article dealt with thirty cases of pilonidal cysts treated at Fort Sill, Oklahoma, Station Hospital, over a period of approximately three months during the latter part of 1941. It encouraged us to accumulate data on similar cases and to present it here as additional information on this relatively frequent and unusually stubborn malady.

No attempt will be made to enter into a discussion of the cause and progress of the condition, but these remarks will be confined to a more or less statistical report of our cases, contrasting our methods of treatment and recording our conclusions.

From November 1940, when this Station Hospital began to function, until August 20, 1942, we have seen and operated upon 200 patients with conditions varying from small non-infected sacrococcygeal dimples to severe, extensive, and ramifying sinuses. This figure does not represent the total number of sacrococcygeal cysts that have come under our observation. In the period before December 7, 1941, a few patients were discharged from active military service because of this physical disability, and at least twenty-five to thirty patients were treated conservatively and returned to duty in good condition without major surgery.

The percentage of incidence is essentially the same here as at Fort Sill; that is, approximately 0.1 per cent, with the majority of races represented. There has been only one case in the Negro race, this

probably being due to our small Negro population at Fort Jackson.

Our cases of sacrococcygeal cysts can be classified under two periods according to the type of operative procedure used: (1) the open method of repair and (2) the closed method of repair. In the first period from the opening of the hospital until March 1, 1942, 123 patients were operated upon, of which approximately 90 per cent of the wounds were left open and packed lightly with iodoform gauze. Sulfanilamide powder was placed in the operative wound of about 40 per cent of the cases with, what we consider, some benefit. During the second period, from March 1st until the present time, seventy-seven patients have been operated upon, of which sixty-three wounds were closed completely, ten partially closed, and four left open and packed with iodoform gauze. Of the sixty-three wounds closed completely, thirty-two, or approximately 50 per cent, healed primarily; that is 42 per cent of the total of seventy-seven patients operated upon in the second period. Of the remaining thirty-one cases, there was more than 50 per cent primary healing in twenty-six cases; in only five did the wound break down completely.

Our method of closure is neither new nor original. Complete hemostasis was obtained and the dead space obliterated by two layers of interrupted sutures of No. 1 chromic catgut, and closure completed by interrupted, deep, transverse, mattress sutures of silk or silkworm gut. We believe that this last suture is important because it prevents inversion of skin which is a frequent cause of failure of the wound to heal primarily. Recently, we have used

silkworm gut exclusively in closing the skin as there seems to be considerably less tissue reaction than when silk or catgut is used.



FIG. 1. Five weeks after original operation and just prior to application of split skin graft to upper limb of wound.

Sulfanilamide was used locally in only six of the wounds that were closed, and in most of these cases there seemed to be rather marked tissue reaction which interfered with healing, but we are of the opinion that most of this was probably due to an excessive amount of the drug being used.

Our preoperative treatment did not differ essentially from that used at Fort Sill, the important thing being to get the infection and the drainage from the pilonidal sinuses cleared up as much as possible prior to operation. Closure was attempted without regard to the severity of infection, the criterion being mainly whether dead space could be obliterated and the wound approximated without too much tension.

Postoperative treatment was as follows: The patient was kept flat for eight hours following spinal anesthesia; liquids were given the day of operation and the day following; a soft diet was given on the second postoperative day and regular diet

on the fifth postoperative day; morphine, gr. $\frac{1}{4}$, was given when necessary for the first twenty-four hours, and codeine and



FIG. 2. Two weeks following application of skin graft, donor wound healed, grafted area completely covered.

aspirin by mouth were sufficient in most cases after the first twenty-four hours. Sutures were removed on the fifth postoperative day. Hot Sitz baths were started on the fifth postoperative day after sutures were removed.

The wound was dressed daily, beginning on the second postoperative day and sutures removed earlier than the fifth postoperative day if infection had developed. In such instances the wound was opened sufficiently to supply adequate drainage and packed with iodoform gauze for from twenty-four to forty-eight hours. The wound was then irrigated with azochloramide-in-triacetin, 1-5000, and some azochloramide was left in the wound. It has been found that after treating the wound with this solution for four or five days, a small amount of sulfanilamide placed in the wound once daily seemed to help considerably in reducing infection and in stimulating granulation. The wound was then allowed to granulate as if it had been left open originally, and in almost every case seemed to heal faster than it would have if it had been left open at the time of

operation, due to the fact that there was usually some healing from each end which had a tendency to pull the wound partially

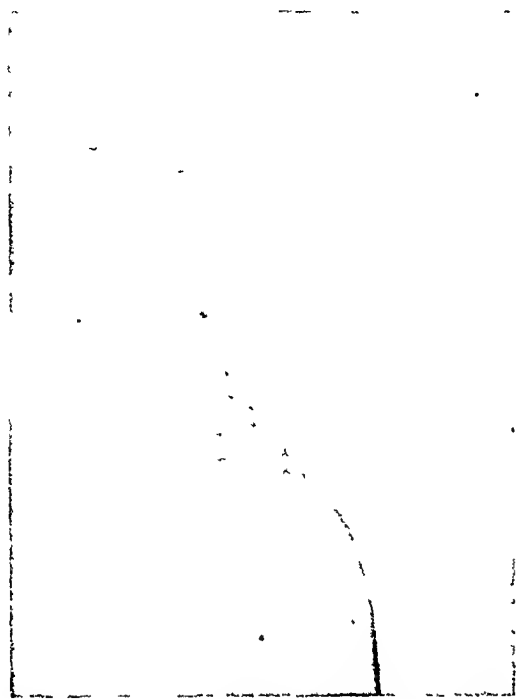


FIG. 3. Three weeks following skin graft, wound healed, patient ready for discharge.

together and leave a smaller area for granulation.

The average number of hospital days required in the open method of treatment was fifty-two; the shortest twenty-seven, the longest 136. In our closed method of treatment, the average number of hospital days was thirty-three; the shortest twelve, and the longest seventy-six. Almost all of the patients with primary healing were kept in the hospital at least eighteen to twenty-one days to insure sufficient healing and prevent breaking down of the wound after the soldier had returned to duty.

As to recurrences, we have had twelve patients who were operated upon by the open method and readmitted with return of symptoms. Six of these, or 50 per cent, have required reoperation, at which time the wound was closed tightly. The other six, all of which healed satisfactorily, were treated conservatively with hot packs, hot Sitz baths, azochloramide packs, and sulfanilamide powder. Of the patients who

were treated by the closed method, only three have been readmitted. Only one of these required reoperation, the others only had mild fissuring of the scar which healed in a few days under hot Sitz baths, azochloramide dressings and local application of sulfanilamide powder.

In only one case did the sinus tract extend into the sacral canal. In three cases, the sinus extended markedly caudal and anterior to the coccyx. The one entering the sacral canal recurred, and this possibly could have been prevented if the coccyx had been removed at operation.

General anesthesia—nitrous oxide and ether—was used in two instances due to personal preference of the patient. Spinal anesthesia—100 mg. of procaine crystals—was used in all other cases. This amount of anesthesia was sufficient in every case except two, in which the spinal anesthesia did not seem to take effect, and it was then supplemented with nitrous oxide-ether anesthesia.

We think it is worthy of note that in the ten wounds closed partially, the proximal and distal portions of the wound being closed and the central area packed with iodoform gauze, the closed areas healed primarily in practically every instance and the central part granulated in rapidly, reducing the number of days of hospitalization materially. It is believed that this is better than putting an excessive amount of tension on the sutures trying to close the wound completely as these wounds become infected and break down in practically every instance.

We realize fully that sufficient time has not elapsed since the beginning of our closed method of treatment for fair comparison with the open method, but our results thus far with the closed method have been so gratifying that we think it amply justifies our enthusiasm.

SUMMARY

We presented the results of 200 cases of pilonidal cysts seen and operated upon

among Army personnel, chiefly new recruits, over a period of twenty-one months. The high incidence and the etiological factor of trauma as previously reported is substantiated. Spinal anesthesia again proves to be the anesthetic of choice. Primary closure was found to be definitely superior to the open method of treatment, both in the results obtained and in the markedly decreased number of hospital days.

ADDENDUM

Since submitting the above paper for publication, we have operated upon 120 additional patients with pilonidal cyst. One hundred of these 120 patients have been operated upon for at least a four-week period and we believe that they should be included in our report. Of the total one hundred cases, ninety wounds were closed tightly and ten were partially closed. Of the ninety that were closed, forty-seven healed primarily and were considered cured; forty broke down partially and required further treatment; three broke down completely and were allowed to granulate from the bottom.

The local application of sulfanilamide powder was used only in those wounds that were definitely infected and draining prior to operation, and this procedure apparently reacted beneficially in helping to obtain primary union.

The postoperative care has been changed somewhat in the group of wounds that did not heal primarily. The two main changes were heliotherapy and skin grafting. The buttock was held apart by means of adhesive strapping as in the original operative procedure, and sun light or artificial ultraviolet light applied directly to the wound. This was used progressively and in graduated doses and definitely shortened the period of healing. We have found that split skin grafts will take on healthy granulations in this area, and this also materially shortens the healing period.

We have had ten patients readmitted to the hospital after discharge to duty, usually from seven to twenty-one days following full duty status. Two of these patients were operated during the open method period. All cases presented from one to three draining sinuses in the middle or lower third of the excisional scar. Upon probing, it was found that the sinuses were moderately superficial and not very extensive. In each instance incision was made opening the sinus from 1 to $1\frac{1}{2}$ inches in length and $\frac{1}{2}$ to 1 inch in depth. The wounds were packed with iodoform gauze for twenty-four hours, after which they were left open and treated as other infected postoperative pilonidal wounds. Rapid granulation and healing occurred in every case, and healing was usually complete within fourteen to twenty-one days without further trouble, proving that the majority of patients readmitted to the hospital with recurrences do not have true recurrences but probably a small pocket beneath the skin filled with serum which aggravation by active duty and rough treatment caused to distend further and break through the skin surfaces.

We submit the following case history with illustrations:

Sgt. W. J. S. gave a history of multiple draining sinuses of the sacrococcygeal region of several years' duration. The involved area extended from the uppermost part of the sacrum down to and involving the perianal region. There were several openings into the right buttock. The entire area was excised; the incision extended to the right and well beyond the anus. We were able to close the entire tract primarily except for the upper limb which extended approximately 10 cm. to the left of the midline. This was allowed to granulate for five weeks and then a large split graft, obtained from the lumbar region, was applied. He was returned to full duty sixty days following the initial operation.

PILONIDAL CYST*

CAPTAIN DAVID BREZIN, M.C., FIRST LIEUT. CARRUTHERS LOVE, M.C.
AND FIRST LIEUT. JOSEPH LAWRENCE, M.C.
FORT BRAGG, NORTH CAROLINA

THIS paper is presented to supplement the report of a new operation and treatment for pilonidal cyst.¹ We have had the opportunity of operating upon thirty additional patients in the two and one-half-month period from April 1st until June 15, 1942. We wish to advocate further that anatomical dissection should replace block excision. We have had occasion to alter the incision and dissection in cases in which the arrangement of the sinus openings demanded it. Minor alterations in the technic are presented. The healing time has been reduced to one-half of that previously reported.¹ The economic implications in reduced healing time for both the Army and civilian practice are obvious.

Anatomical Dissection. Because the incidence of pilonidal cyst is high at this Post, we have had almost daily contact with the condition at the operating table. Inquiry has revealed that the incidence is high elsewhere in the Army. A report² by Pickett and Beatty from Fort Sill, Oklahoma, in which thirty patients were operated upon in ninety-seven days is confirmatory.

Frequent contact with pilonidal cyst, in a brief period of time, has permitted observation not only of the numerous variations which the cysts and sinus arrangements may assume, but a particular phase of technic started, could, in a similar case, be improved upon while it is still fresh in mind. Likewise, it is this frequent contact with the operation which has done most to dispel the idea that a mystery enshrouds the ramifications of the sinus tracts and the sacculations. It has been a maxim handed down through medical school and from surgeon to surgeon, that in order to excise a pilonidal cyst completely, one must remove "en bloc,"

the skin, cyst and a wide area of surrounding tissue. Because tracts and cyst walls ramify laterally and downward toward the anus this type of excision will fail in upwards of 25 per cent of the cases. One has not only sacrificed a great deal of normal tissue but has left sac wall for recurrences.

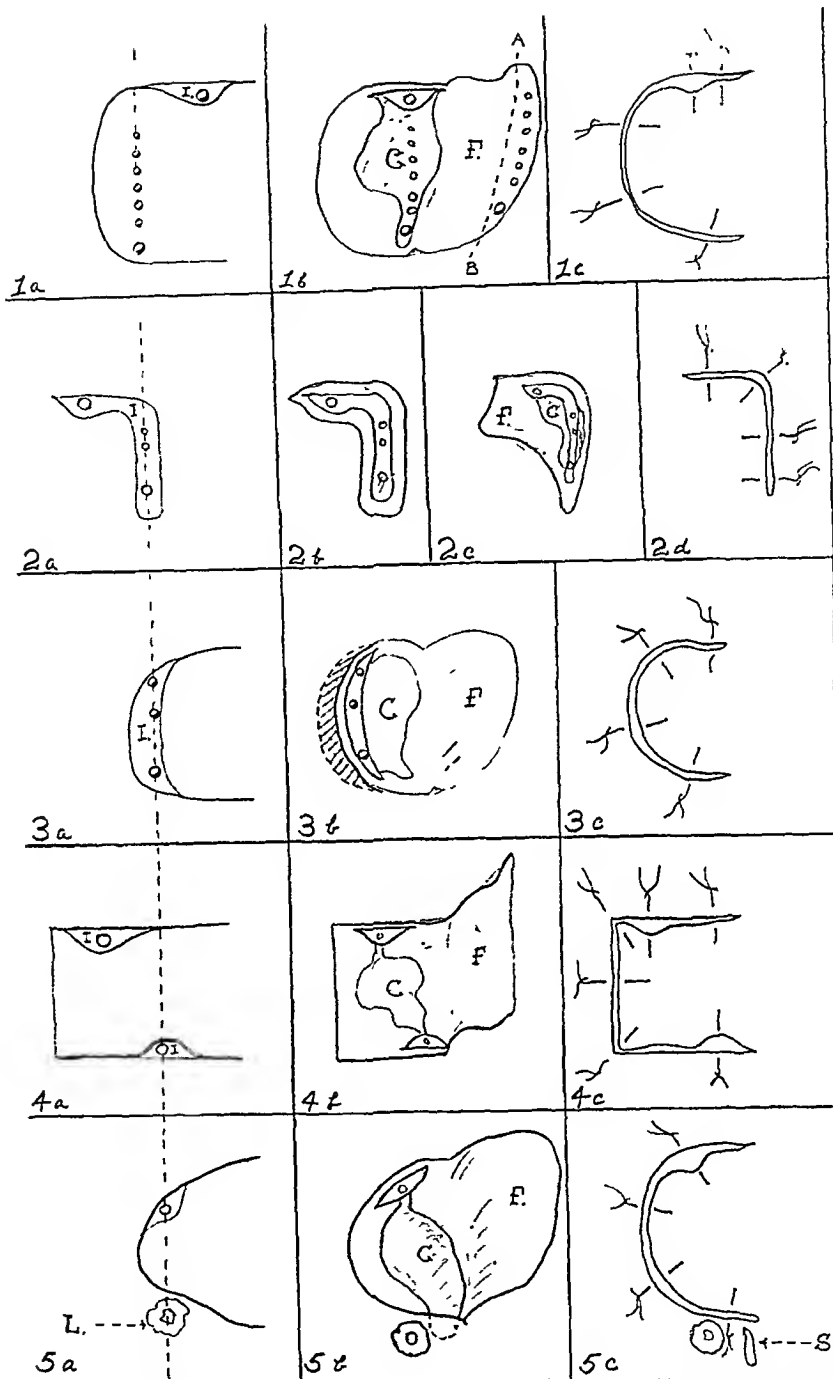
On the other hand, by leaving an island of skin about the sinus openings and tracing the underlying structures with the aid of methylene blue stain and a probe for guidance, the problem of dissection is no more complicated than for fistulas or sinus tracts elsewhere in the body. It is true that fibrous cords which are not patent and cannot be probed may extend from the sac. Occasionally, a fibrous cord $\frac{1}{4}$ inch in diameter extends upward directly under the skin in the midline for 1 to 2 inches. That these cords cannot be probed or do not stain is of no significance, since they are perfectly recognizable in dissection and one may remove them with the sac *in toto*.

We broadly inferred in the first report¹ that we believed the chances for complete removal were infinitely increased by anatomical dissection. Almost daily experience with dissection of complete sinus tracts and cysts has confirmed this opinion, and it has become quite obvious to us that the rationale for block excision has no "raison d'être."

Additional Types of Incisions and Dissections. We believe that the variations which the sinus openings assume, the incision and dissection employed for each, may best be presented by diagrammatic drawings. (Figs. 1 to 5.)

One of us (C. L.) has advocated the use of a rectangular flap instead of the U-shaped flap originally described.¹ (Fig. 4.) In some instances this is more advantageous in

* From the Septic Surgical Section, Station Hospital, Fort Bragg, N. C.



FIGS. 1 TO 5. In Figures 1, 3, 4 and 5, a represents the incision, b the reflection of the flap with exposure of the sac, c the refitting of the flap with suture. Figure 2b represents undercutting of the skin edges about the skin island. The interrupted line running through a Figures 1 to 5 represents the midline; the heavy black line is the incision. I is the skin island left around the sinus openings which are depicted as small circles. C is the exposed cyst. F the reflected flap. Figure 1b, the interrupted line A to B represents excision of skin and sinus openings trimmed off flap. Figure 3b cross hatching outlines additional skin removed so the flap will fit better after dead space is obliterated. Figure 5, L is the anus, S is the stab wound described in the text.

that the subsequent refitting of the flap into the defect is more easily accomplished.

Refinements in Technic. There have been a few minor refinements in technic and care, but these have materially aided in reducing the healing time still further.

Further experience with the operation has enabled us to become more ingenious, and we were able to effect complete closure in all cases of this series. Separation at the lower angle following removal of sutures still occurs. Now, however, we do not continue to reapply sulfathiazole, cod-liver oil, lanolin dressings for more than two or three days, because we found that the skin edges were kept too soft. After the period of ointment dressings, we paint the whole wound and lower angle either with tincture of merthiolate or 10 per cent mercurochrome. These dry the skin edges and permit the serum to crust. Epithelization occurs underneath.

We have also learned to approximate the skin edges loosely near the lower angle, to permit the ointment placed in the depths of the wound to leak out. Pressure exerted by having the patient lie on his back is a further aid in this direction. The approximation of skin edges is better if all the silkworm Stewart sutures are tied on the skin edge opposite the flap. (Figs. 1 to 5.)

Results. The average healing time in this series of thirty cases is 13.3 days. This is approximately one-half the average healing time reported for the original series of thirty cases,¹ and must be compared to the healing time following block excision which may be from eight weeks to upward of six months. The healing time ranged in days from six to twenty-six. We do not believe that the healing time can be reduced below this level. Because healing was so rapid, to insure good results we recommended a two weeks furlough for all patients before they returned to duty. We attribute the marked improvement in healing time to our ability to effect complete closure in all cases.

We have now had five cases in which large sacculations extended downward and were subjacent to the skin lateral to the anus. These were completely closed but a

small stab wound was placed lateral to the anus through which the ointment could drain. These have all healed per primum.

We have now been able to follow up about 50 per cent of the original series of thirty cases for three to five months and a similar number of the first cases in this series for one and one-half to two months. Except for one case, all the patients followed, are solidly healed. The scar fades and becomes barely perceptible. There has been no complaint of pain, no abscess formation nor recurrence. The one case excepted presented himself for hospitalization three weeks following discharge; the lower angle was open and there was a midline tunnel under the flap from the lower angle extending to the upper limit of the healed flap. Although the wound was completely healed on discharge it was not solid enough to withstand sliding into home plate during a baseball game two weeks later. Daily insertion of the ointment into the tunnel brought about granulation closure in one week.

In those cases in which the cyst wall was dissected away from the anal sphincters and anal wall, there has been no change in bowel habits.

SUMMARY

1. A supplementary report of thirty additional cases of pilonidal cyst operated and treated by a new method, is presented.
2. Anatomical dissection is advocated; block excision is deprecated.
3. Diagrammatic sketches are presented to show various sinus arrangements and the incision and dissection employed for each.
4. Minor variations in technic are described.
5. The average healing time for thirty cases is 13.3 days. Follow-up indicates very good results.

REFERENCES

1. BREZIN, DAVID. Pilonidal cyst, a new procedure for operation and treatment. *Am. J. Surg.*, 59: 18, 1943.
2. PICKETT, W. J. and BEATTY, A. J. Pilonidal cyst in the army. A report of 30 cases occurring in 97 days at Fort Sill, Oklahoma. *Am. J. Surg.*, 56: 375, 1942.

DEMEROL HYDROCHLORIDE

A NEW DRUG IN THE PRACTICE OF SURGERY

M. L. WEINSTEIN, M.D.

Member of Senior Surgical Staff, Chicago Memorial Hospital

CHICAGO, ILLINOIS

AMERICAN literature reveals only a brief amount of clinical information concerning this new drug. Eisleb and Schaumann¹ discovered Demerol in 1939 in the course of a search for compounds having spasmolytic properties of the atropine series of drugs. It was introduced in Europe as Dolantin, Dolantol, D-140. The chemical structure is 1-methyl-4-phenylpiperidine-4-carbonic acid ethylester, with the following formula (Fig. 1):

Demerol is a white crystalline substance slightly soluble in water and with a strong alkaline reaction. The hydrochloride is employed medicinally as it is readily soluble in water and has a neutral reaction, with a slightly bitter taste. The solution is not decomposed by a short boiling period.

Demerol hydrochloride has a distinct relaxing action on the smooth muscles of the bowel, the uterus, the bronchial tree and the urinary bladder. This action is said to be due in part to depression of the parasympathetic endings, but primarily is the result of a direct depressive effect on the muscles themselves resembling the effect of papaverine.

In experimental work with animals, it was found that toxic doses of Demerol Hydrochloride produced excitement, salivation, and ataxia; and that extreme doses caused ataxia associated with spasticity and chronic convulsions. Prolonged use of the drug was found not to affect the hematopoietic system in dogs. Continued use of the drug may cause habituation but not addiction.

Demerol Hydrochloride is broken down very rapidly after oral or parenteral administration to the intact animal. The rapidity of the breakdown makes it very

difficult to trace the components of the drug. Only in extremely toxic doses is presence of the drug demonstrated in the

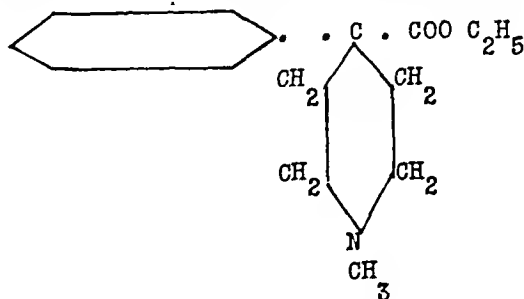


FIG. 1. Chemical formula.

urine. It is thought to be broken down by the liver and to a much lesser extent by tissues of the central nervous system.

Demerol Hydrochloride is nonhemolytic, is a depressant to smooth muscle tissue, and has an antagonistic action to acetylcholine on the heart and intestines as well as an antagonistic action to histamine on the intestines. It is an effective antispasmodic, relatively nontoxic and non-narcotic in action.

In therapy, Demerol Hydrochloride possesses three main properties: analgesic, antispasmodic and sedative. The analgesic action is comparable to that of morphine. Its antispasmodic action is comparable to and even superior to that of the opiates. The sedative effect is definite, sleep is produced but not as deeply as with morphine. Therapeutic doses produce a slightly sedative and marked analgesic action. Large doses temporarily reduce the blood pressure with slowing of respiration, although ordinary doses affect neither the blood pressure nor the respiration.

In animals, there is no evidence of physical dependence following repeated doses

of the drug, nor does toleration or accumulation occur in them. In men, the analgesic effect appears to be between that of morphine and codeine and persists from three to six hours. Occasionally, the drug will produce a euphoria which lasts only a short time.

Duguid and Heathcote,² in 1940, repeated the experiments and confirmed the findings of Eisleb and Schaumann¹ on Demerol. In 1941, Gruber, Hart, and Gruber³ made a complete review of the work of Eisleb and Schaumann and reported confirmation of their studies on Demerol. In 1942, Barlow⁴ made a careful study of this drug and corroborated the findings previously reported.

My experience in the use of Demerol Hydrochloride has been gained in the cases as shown in the opposite column.

The only untoward effects noted in these cases were occasional slight nausea, slight dizziness, flushing of face, sweating, and dryness of mouth, and also slight feeling of weakness or syncope. These effects were of brief duration and as a rule did not cause any inconvenience to the patients.

Demerol Hydrochloride was used in all the above cases with satisfying results without resorting to the use of morphine. Almost without exception, patients were relieved of their pain and sufficient rest was obtained to warrant further use of the drug.

My observations in these cases showed the following comparison between the results of Demerol Hydrochloride and morphine:

	Demerol Hydrochloride	Morphine
1 Nausea and vomiting	Slight	Fairly common
2 As a preoperative drug	Synergistic to anesthesia. Only slight depression of respiration, blood pressure, and pulse	Depressing to respiration, blood pressure, and pulse
3 Constipation	None	Common
4 Action	Combined action of morphine and atropine	Atropine usually added
5 Analgesia	Equal to that of morphine, but with less depression	
6 As a postoperative drug	May be used frequently with little danger of addiction or habituation	Caution must be used against both addiction and habituation

Surgical Procedures	Number
Exploration of common duct	2
Cholecystectomy	12
Appendectomy	42
Ventral suspension with appendectomy	1
Excision of large simple ovarian cyst with appendectomy	2
Thyroidectomy	5
Subtotal hysterectomy	8
Total hysterectomy	8
Cesarean section	1
Femoral herniotomy	1
Inguinal herniotomy	2
Ventral herniotomy	1
Resection of sigmoid	1
Second stage Nikulicz	1
Colostomy closure	1
Coagulation of tumor of rectum	1
Nephrectomy	1
Excision and plastic for radiation burn over sacrum	1
Excision of metastasis of glands in neck	1
Adnexal operations on tubes and ovaries and round ligaments	8
Radical mastectomy	3
Talma-Morison operation	1
Suprapubic prostatectomy	1
Suprapubic cystotomy for carcinoma of bladder, with radium insertion	1
Genitourinary procedures consisting of cystoscopic pyelograms and bladder fulgurations	14
Meckel's diverticulum	2
Transurethral resection of bladder carcinoma	1
Dilatation and curettage for biopsy	6
Hemorrhoidectomy and excision of rectal fissure	12
Excision of Bartholin's glands	2
Drainage of axillary abscess	1
Excision of pilonidal cyst	1
Incision and drainage of arm	1
Suture of palmar surface of hand	1
Excision of cyst from forehead	1
Excision of cyst of neck	1
Excision of tumor of neck	1
Excision of foreign body from cheek	1
Excision of tumor of left wrist	1
Excision of lipoma of hip	1
Incision of perirectal abscess	1
Biopsy of tumor of rectum, with radon insertion	1
Removal of tonsils and adenoids	11
Fracture of spine—cast	1
Fracture of humerus—reduction and cast	1
Colles' fracture—reduction and cast	1
Bilateral saphenous vein ligation	8
Salpingectomy for tubal pregnancy	4
Stomach resection	1
	182

Additional Cases Treated

Primary carcinoma of lung, inoperable	2
Metastasis following carcinoma of breast amputation, inoperable	2
Thrombophlebitis of femoral vein	3
	7
Total cases	189

We have found Demerol Hydrochloride ideal as a preanesthetic medication. It is particularly valuable in surgery of the mouth and throat in which analgesia and control of the salivary flow are desired, and also as a routine preoperative sedative to replace the use of morphine and atropine frequently employed by many surgeons. Batterman and Rovenstine⁵ recently reported on the utility of Demerol as a substitute for the opiates in preanesthetic medication. Also, Batterman and Mulholland⁶ have recently reported on the use of Demerol as a substitute for morphine in the treatment of postoperative pain.

My experience with the use of Demerol Hydrochloride preoperatively and postoperatively has proved that 100 mg. is sufficient for the ordinary adult, and in many cases 50 mg., or half an ampule, is ample. This dose usually is effective within fifteen minutes by hypo. The drug may also be given orally in 50 mg. tablets, with two tablets to the dose, producing analgesia within twenty to sixty minutes. However, I have found the parenteral route definitely more satisfactory.

The dosage should vary according to the age, weight, and general condition of the patient, in the same manner as for morphine, i.e., for a senile patient 50 mg. should suffice but this may be repeated pro re nata; and for children, 10 to 50 mg. per hypo or double this dose in tablet form, dosage ranging according to age and weight.

Sprockhoff⁷ in a recent article attests to the safety of Demerol Hydrochloride for children, reporting his vast experience in

use of the drug, with good results, in croup and whooping cough.

Batterman⁸ in recent studies on this new drug, emphasizes the effectiveness and safety thereof for relief of pain in medical and surgical conditions.

SUMMARY

1. Demerol Hydrochloride is a safe analgesic and antispasmodic drug.
2. In ordinary dosage, it is not depressing to the respiratory or circulatory systems.
3. It does not damage the hematopoietic system.
4. It may be used preoperatively with safety as a synergist with all types of anesthesia.
5. It may be used postoperatively to replace morphine in almost all cases.
6. Demerol Hydrochloride has all the advantages of morphine but few of its disadvantages.
7. The use of Demerol Hydrochloride in surgical practice is recommended for the alleviation of pain.

REFERENCES

1. EISLEB, O. and SCHAUMANN, O. *Deutsche med. Wchnschr.*, 65: 967, 1939.
2. DUGUID, A. M. E. and HEATHCOTE, R. St. A. *Quart. J. Pharm. Pharmacol.*, 13: 318, 1940.
3. GRUBER, C. M., HART, E. R. and GRUBER, C. M., JR. *J. Pharm. & Exper. Therap.*, 73: 319, 1941.
4. BARLOW, O. W. Personal communication.
5. BATTERMAN, R. C. and ROVENSTINE, E. A. *Anesthesiology*, (in press).
6. BATTERMAN, R. C. and MULHOLLAND, J. H. *Arch. Surg.*, (in press).
7. SPROCKHOFF, O. *Deutsche med. Wchnschr.*, 67: 383, 1941.
8. BATTERMAN, R. C. *Arch. Int. Med.*, (in press); *Tr. Am. Therap. Soc.* (in press).



LOBELIN IN ASPHYXIA DURING GUNSHOT SURGERY*

ANDREW J. TOMAN, M.D.†

CHICAGO, ILLINOIS

WITH the increasing participation of the United States in the war, penetrating wounds are of particular concern to the surgeon. The wounds received in military combat are more severe than those encountered in civilian life, nevertheless, there are no essential differences in the nature of these wounds. The causes of death are the same in each instance, either hemorrhage or shock, while if these are survived, peritonitis, as in the case of abdominal wounds, may be the factor in the ultimate death of the patient. That military mortality, as a result of gunshot wounds, is considerably higher than in civilian life is easily understood in that military casualties in most cases cannot be given the immediate surgical care and attention which is possible in the case of civilian injuries.

Asphyxia is a frequent problem in the surgical repair of gunshot wounds. This is especially true during the exploratory operations necessary in the case of abdominal wounds. Asphyxia may result because of shock or because of failure of the respiratory center during anesthesia. Postoperative asphyxia because of overdoses of morphine, veronal and other drugs must also be considered.

There are several methods employed in the treatment of these conditions. Artificial respiration, while valuable, is often impractical. The administration of atropine, caffeine or strychnine may be tried, yet there are limitations to this treatment and contraindications which may preclude its use.

After watching the results obtained, in many hospitals, in cases of asphyxia neonatorum by the use of Lobelin, we

made use of this product in our early experiments and finally selected this drug for a long range test in the treatment of asphyxia during gunshot surgery.

One hundred seventeen cases of asphyxia due to shock came to our attention during these experiments. All were police cases, brought to our institution following gang wars, fights and robberies. All were abdominal wounds, having multiple gut perforations and most of the patients were in complete shock upon their arrival in surgery, more than one hour after the injury.

In ninety-six of these cases, Lobelin was administered as soon as respiratory failure was observed and in all ninety-six cases this condition was successfully overcome. One cc. of Lobelin was injected intravenously and in a few seconds, cyanosis had disappeared, respiration became normal and surgical procedures could be resumed. In the remaining twenty-one cases other methods were used and the high percentage of mortality which occurred convinced us that only Lobelin answered our need for a quick-acting, satisfactory respiratory stimulant. Lobelin, when injected intravenously reacted favorably within eleven seconds, regardless of the dose and the effects lasted for twenty minutes. In no cases was a second injection necessary. Intramuscular and subcutaneous injections of Lobelin were also tried but since the reactions produced by these methods were slow and doubtful, these procedures were abandoned in favor of the highly satisfactory intravenous injection. (Table 1.)

Lobelin is obtained from the herb *Lobelia inflata*, a member of the nicotine

* From the Department of Surgery, House of Correction Emergency Hospital, Chicago, Illinois.

† At the present time A. J. Toman, M.D., is in the Medical Corps of the U.S. Naval Reserve. The material submitted in this article has no connection with cases in the U.S. Navy.

group. However, unlike the other members of this group, Lobelin does not demonstrate the toxicity or other ill effects attributed to the nicotines. Recognized in 1813 by Cutler, it was first isolated only in the form of impure, amorphous salts. In 1916, Wieland¹ succeeded in preparing a pure, crystalline hydrochloride salt from the plant which is known chemically as Alpha-Lobelin Hydrochloride with the empirical formula $C_{22}H_{27}O_2N \text{ HCl}$.

TABLE I

No. Cases Treated	Cases in Which Lobelin Was Administered	Cases in Which Other Methods Were Employed	Recovered after Lobelin Administration	Recovered after Other Methods
117	96	21	96	0

Solis-Cohen and Githens² state that pure Lobelin has a stimulating effect upon the respiratory center and does not cause nausea, even after the administration of large doses. Sollman³ states that Lobelin if injected lowers the carbon dioxide threshold and produces a marked stimulation of respiratory movements. Meyer and Gottlieb⁴ state that Lobelin stimulates

the respiratory center and may be administered intravenously or intramuscularly to strengthen and increase the respirations. They believe that it is particularly useful in respiratory paralysis during narcosis.*

SUMMARY

1. Asphyxia resulting from shock requires the administration of a quick-acting respiratory stimulant.

2. In all cases of this type, in which Lobelin was administered, respirations became evident and normal within two or three seconds after intravenous injection.

3. One injection was sufficient in all cases and no further means of treatment, such as oxygen or artificial respiration, were necessary.

REFERENCES

1. WIELAND, H. *Arch. f. exper. Patb. u. Pharmacol.*, 79: 95, 1916.
2. SOLIS-COHEN, S. and GITHENS, T. S. *Pharmacotherapeutics. Materia Medica and Drug Action.* Pp. 1798-1801, 1928.
3. SOLLMANN, T. A. *Manual of Pharmacology*, pp. 416-417, 1926.
4. MEYER, H. H. and GOTTLIEB, R. *Exper. Pharmacol.*, pp. 362-363, 1926.

* The Lobelin used in these experiments was manufactured by Ernst Bischoff Company of Ivoryton, Connecticut, and is known commercially as "Lobelin-Bischoff."



Case Reports

MADELUNG'S DEFORMITY IN SISTERS*

MAJOR DAVID SLOANE, M.C., A.U.S.

Diplomate of the American Board of Orthopedic Surgery; Associate Orthopedic Surgeon, New Rochelle Hospital
LARCHMONT, NEW YORK

I WISH to report the occurrence of Madelung's deformity in sisters with a brief survey of this rather unusual deformity.

CASE REPORTS

CASE 1. Clara C., unmarried colored girl, age forty, was first seen at the Orthopedic Clinic of the New Rochelle Hospital in January, 1942. Her chief complaint was stiffness of her fingers for the past three months. The condition first began in the right hand and later spread to the left. The primary pathological condition was an acute arthritis of her hands and wrists, but during the course of the examination, the prominence of the ulnae suggestive of Madelung's deformity, was recognized.

The patient's wrist gave no trouble during childhood or adulthood until about three years ago at which time her wrists began to ache after heavy lifting or prolonged washing of clothes. As far back as she could remember the lower ends of the ulnae were prominent. It was her painful arthritis that brought her to us. The Madelung's deformity was only an incidental finding.

Menstrual history was regular, twenty-eight day cycle, lasting five or six days. Quite recently her periods increased to nine days. Examination at the hospital revealed a fibroid uterus as the cause.

The patient has five brothers and one sister. Her parents and three brothers are dead and she has lost track of the remaining two brothers. The only relative she has contact with is her younger sister, described below as Case II. However, she never did notice any prominence of the wrists of any of the other members of her family.

Examination of the wrists revealed a prominence of the lower ends of both ulnae somewhat more marked on the left. (Fig. 1.) The right hand appears to be displaced ventrally. This is the so-called "bayonet deformity." This apparent displacement is not as marked on the left side. There is an old scar on the dorsum of the right hand caused by a childhood injury and irrelevant to the present deformity. The fingers of both hands are held in marked flexion with swelling of the interphalangeal joints. This flexion is the result of an acute arthritis unrelated to Madelung's deformity.

Motion of the right wrist is restricted to about 10 degrees of activity. The fingers are flexed to almost 90 degrees with very little phalangeal motion. Abduction and adduction of the hand are practically zero. Pronation 45 degrees from a neutral midline position; supination 45 degrees. Most of this restriction is on an arthritic basis.

Motion of the left wrist shows dorsiflexion of 45 degrees, palmar-flexion of 30 degrees; adduction (ulnar deviation) 30 degrees, abduction (radial deviation) 5 degrees. Pronation 70 degrees from a neutral midline position; supination 60 degrees.

Sensation is normal in both upper extremities and x-rays have ruled out cervical ribs.

Sedimentation Rate (Rourke method): Normal is 0.08 to 0.35 mm. per minute. On April 1, 1942, it was 0.62, on April 13, 1942, 0.65.

Blood count on March 31, 1942, was as follows: White blood cells, 6,500; red blood cells, 4,520,000; hemoglobin, 89; color index, 0.9; polymorphonuclears, 46 per cent; unsegmented, 0; eosinophiles, 2 per cent; basophiles, 0; lymphocytes, 38 per cent; large mononuclears, 14 per cent. A blood Wassermann (April 2, 1942), showed 4 plus \bar{c} cholesterinized

* From the Orthopedic Service of New Rochelle Hospital, New Rochelle, New York.

antigen, 1 plus \bar{c} acetone insoluble antigen. The patient had had antiluetic therapy three years ago.

("bayonet deformity"). All these changes were more marked on the left side. The grip of her hand was quite strong on both sides.

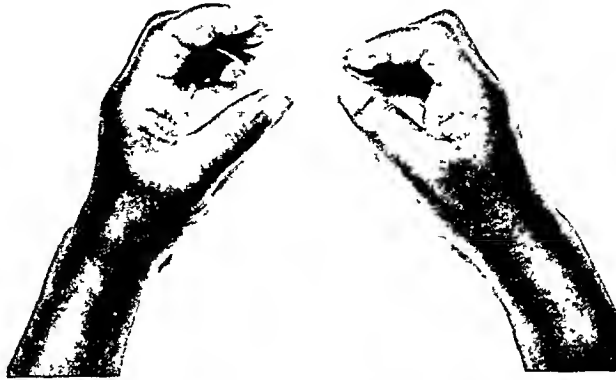


FIG. 1. Case 1. Note the prominence of the ulna at the wrists. The superimposed arthritic deformity is clearly discernible.

X-ray examination of the wrists and hands (Figs. 2 and 3) revealed marked prominence and dorsal displacement of the lower end of the ulna; a pseudoventral displacement of the hand ("bayonet deformity"); downward and ulnarward tilt of a triangular lower radial epiphysis and a pyramid-shaped carpus (pyramidalization) with its apex at the lunate (semilunar) bone. The changes noted were present about equally on both sides. They are typical of Madelung's deformity. There was also a small osteophyte noted on the lower end of the right radius abutting against the ulna. (Fig. 2.)

CASE 11. Leola C., unmarried colored girl, age twenty-three, came to the Orthopedic clinic at the New Rochelle Hospital in March, 1942, complaining of a mild sprain of the right wrist. Upon examination the deformity of her wrists was promptly detected and the fact noted that she was a sister of the above described patient. (Case 1.) Prior to the present injury her wrists had never given her any trouble, although they were prominent as far back as she could remember.

Except for her family history (described above in Case 1) the only other relevant fact was an irregular menstrual history. Onset occurred at fifteen years of age; irregular twenty-eight day cycle, duration two to three days but at times as long as four to five days with occasional menorrhagia.

Examination of the wrists revealed a marked prominence of the lower end of both ulnae. There was dorsal bowing of the forearms while the hands appeared to be displaced ventrally

Motion of right wrist showed dorsiflexion 45 degrees, palmar-flexion 70 degrees; radial deviation (abduction) 5 degrees; ulnar deviation (adduction) 35 degrees; pronation from the neutral midline 80 degrees; supination 30 degrees.

Motion of the left wrist showed dorsiflexion 45 degrees, palmar-flexion 60 degrees; radial deviation (abduction) 5 degrees; ulnar deviation (adduction) 35 degrees; pronation from neutral midline 80 degrees, supination 80 degrees.

X-ray examination of the wrists and hands (Figs. 5 and 6) revealed the typical changes of Madelung's deformity. On the right side there was a slight ventral turning down of the lower end of the radius with prominence of the ulna, and pseudoventral displacement of the hand. The dorsal view disclosed the typical pyramid-shaped carpus, with the radial epiphysis sloping ulnarward about 45 degrees. On the left side there were similar changes with the lower end of the radius markedly ventrad and marked prominence of the lower end of the ulna. In addition there was a small cystic area at the lower end of the left radius.

Definition. Madelung's deformity is essentially a growth disturbance of the lower radius resulting in dorsolateral bowing of that bone with ventro-ulnar deviation of the hand at the wrist and a concomitant prominence of the lower end of the ulna. In 1878, Madelung¹ focused attention on this clinical entity by describing the

autopsy findings in a woman of twenty and mentioning twelve other cases which he had seen. It is noteworthy that Made-

Age. The condition starts during adolescence between the ages of ten and fourteen. Progress of the deformity ceases



FIG. 2. Case 1. Right hand. Note tilting of lower radial epiphysis, obliquity of lower end of radius on dorsal view, the pyramid-shaped carpus, and the dorsal position and prominence of lower ulna. Note particularly the osteophyte at the lower end of the radius abutting on the ulna.



FIG. 3. Case 1. Left hand. Changes similar to the right side.

lung's description of this condition appeared almost two decades before the advent of x-ray.

Incidence. While the European literature on Madelung's deformity is quite extensive, American reports are by no means as abundant. The first American report was by Pooley² in 1880. He was evidently unaware of Madelung's work and described the condition independently. An extensive and excellent survey was made by Anton, Retez, and Spiegel³ in 1938. They thoroughly analyzed 171 authentic cases reported up to that time. Of this number only twenty were American cases to which they added the twenty first.

Sex Ratio. There is a preponderance of females in the ratio of 4 to 1.

Involvement. About 75 per cent of the reported cases are bilateral. Among the bilateral cases it is usually the right side which is apt to be more severely involved. When both sides are affected, one side is involved somewhat earlier than the other. Of the unilateral cases the incidence of the side involved is about equally divided.

with the termination of normal growth at the wrist. By the age of twenty-five it is safe to assume that the deformity is stationary. This is very important in therapy.

Heredity. Heredity is said to be a factor in about one-third of the reported cases. I have personally seen about ten cases over a period of many years. I do not recall any hereditary factor with the exception of the two above reported cases.

Cause. Occupation and environment are not etiological factors. While trauma may injure the lower radial epiphysis with resulting deformity, a genuine Madelung's is nontraumatic. Rickets may be dismissed by the fact that these cases show no signs of rickets in other parts of the body.

The pressure of cervical ribs has been suggested⁴ but this idea may be discarded as exceedingly few of these cases have cervical ribs. By x-ray and clinical examination my two patients were free of cervical ribs.

Ovarian dysfunction⁵ has been advanced as a possible cause. Certainly the vast number of women with ovarian dysfunction ought to produce more than a mere handful of Madelung's cases.

The most likely explanation of Madelung's deformity is on the basis of a dyschondroplasia of the lower radial epiphysis. This has been suggested by others³ because of the rarity of the condition, uniformity of the age of onset during the secondary growth period, its tendency to bilateral occurrence and the absence of a traumatic history or the stigma of rickets.

Symptomatology. With insidious onset the condition first begins in one wrist during early adolescence at about thirteen years of age. Pain and deformity about the wrist are the main symptoms. Pain at times may be very mild and usually ceases with the termination of wrist growth at about twenty-five years of age. There is apt to be some limitation of wrist motion although this is mild and in proportion to the extent of actual deformity.

Wrist deformity is the cardinal complaint. The articular face of the lower radius (really the epiphysis) turns downward (ventrally) and carries the wrist and hand along with it. The lower end of the radius bends to accommodate this change so that a dorsal radial bowing of the shaft results. There is an apparent pseudodislocation of the wrist, the so-called "bayonet deformity." There is concomitant lateral bowing of the radial shaft with a widening of the interosseous space. As the lower radius turns downward the ulna continues its normal straightline growth and consequently becomes very prominent. It is this prominence of the lower end of the ulna that very often calls our attention to the painless, hitherto unrecognized case of Madelung's deformity.

In addition to the above changes the lower radial epiphysis fuses prematurely at its inner (ulnar) side. The outer side of the radial epiphysis continues to grow and throws the wrist and hand into adduction (ulnar deviation).

Joint restriction naturally varies with the extent of mechanical deformity. Flexion of the wrist is apt to be increased with extension limited. Adduction (ulnar deviation)

tends to be increased with abduction (radial deviation) limited.

There is a "reverse Madelung" de-



FIG. 4. Case 11. Note the broad wrists, prominent ulnae and "bayonet deformity."

formity in which the lower radius and hand turn upward while the ulna displaces ventrally. This deformity is exceedingly rare as there are only five cases described in all the literature.³

Roentgenologic Picture. Although Madelung described this condition long before the advent of x-rays, it is only by a careful study of the film that we can really understand this condition.

The following criteria have been described as important:⁶

1. The radial shaft arches dorsally and laterally. The dorsal bowing carries the distal end (including the epiphysis) downward. The lateral bowing is really an increase in the normal curve of the radius. This increases the interosseous space and is best viewed in the anteroposterior film with the hand and forearm flat on the plate in full pronation. The actual length of the radius is shorter than normal.

2. Premature fusion takes place at the inner (ulnar) side of the lower radial epiphysis. The epiphysis assumes a triangular outline with the apex situated medially (ulnarward). The lateral half of the epiphysis continues to grow pushing the hand into ulnar deviation (adduction). The articular surface of the lower radius faces internally (ulnarward) and ventrally (palmarward). On lateral view the lower end of the ulna

grows forward normally and eventually assumes a prominent position dorsal to the radius. In a so-called "reverse Madelung"

itself justify operative surgery. Temporary immobilization and physiotherapy to the wrist should be sufficient to tide one over

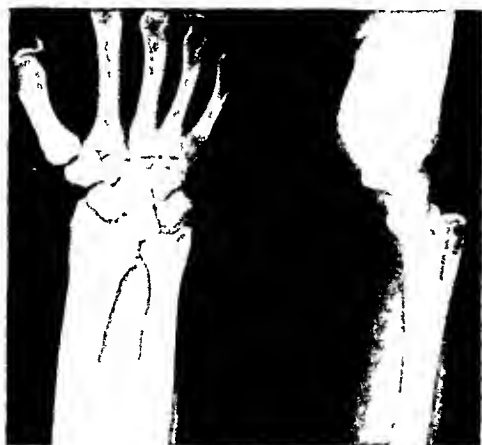


FIG. 5. Case 11. Right hand. Note pseudo-dislocation of the hand ("bayonet deformity"), oblique lower radius, prominent dorsal ulna and pyramidal carpus.



FIG. 6. Case 11. Left hand. Changes as in right hand but more marked. Note particularly in the lateral view the cystic area in the lower radius about half an inch above the wrist joint.

the ulna lies ventral with the wrist and hand dorsal.

3. The carpus becomes wedged between the deformed radius and protruding ulna and assumes a triangular appearance with the os lunatum (semilunar) at the apex. This has been called the "pyramidalization" of the carpus.

4. Bony excrescences or even definite exostoses may be present along the ulnar border of the lower radius. In addition an area of bone absorption on the ulnar border of the radial metaphysis may be present a variable distance above the epiphyseal region. This exostosis (Fig. 2) and cystic area (Fig. 6) may be seen in the above cases.

TREATMENT

In considering therapy we must remember that the condition actively progresses until growth ceases. Pain, if present at all, stops with cessation of wrist growth. Consequently, pain, unless very severe which is not apt to be the case, does not by

the active period of active growth. Any corrective surgery performed during this growth period is likely to become nullified and may have to be done over again.

When growth ceases—and we can consider twenty-five years to be the safe age—a corrective wedge osteotomy of the lower radius and a resection of the lower end of the ulna are the indicated surgical procedures in cases of marked deformity.

REFERENCES

1. MADELUNG, O. W. Die Spontane Subluxation der Hand nach vorne. *Verhandl. d. deutsch. Gesellsch. f. Chir.*, 7: 259, 1878.
2. POOLEY, J. H. Congenital Dislocation of the Wrists. *Am. Practitioner Med.*, 21: 216, 1880.
3. ANTON, J. J., REITZ, G. B. and SPIEGEL, M. B. Madelung's deformity. *Ann. Surg.*, 108: 411, 1938.
4. KAJON, C. Madelung's deformity combined with cervical ribs. *Wien. med. Wchnschr.*, 84: 460, 1934.
5. BEDER, W. L. and HEINISMAN, J. I. Importance of endocrine (ovarian) dysfunction in genesis of Madelung's deformity. *Fortschr. a. d. Geb. d. Rontgenstrahlen*, 52: 595, 1935.
6. DANNENBERG, M., ANTON, J. J. and SPIEGEL, M. B. Madelung's deformity; roentgenologic diagnostic criteria. *Am. J. Roentgenol.*, 42: 671, 1939.

MYOCARDIAL ABSCESS WITH PERFORATION OF THE HEART FOLLOWING STAPHYLOCOCCAL PYEMIA*

JAMES R. GLADDEN, M.D.

Department of Surgery, Howard University

WASHINGTON, D. C.

THE record of one case of myocardial abscess with perforation of the heart and a review of the literature concerning this condition is included in this report. This case is of interest not only because the condition is rare, but also because of the management. The history was misleading and not complete, and the initial diagnosis certainly influenced the treatment thereafter. Possible methods of treatment that may have been instituted earlier were not given an opportunity to prove their value.

CASE REPORT

S. P., aged six years, was admitted to Provident Hospital on July 23, 1941, with a history of attacks of pains in his joints and frequent colds. Early on the morning of the day of admission the child was unable to walk, seemed delirious, and mother had to lift the child out of bed. During the afternoon the child attempted to stand and was unable to do so. He complained of severe pains in the region of his left knee.

The history of the patient prior to admission revealed frequent colds during the winter season, and headaches from time to time that often lasted the entire day. The child obtained some relief from the latter attacks following medication of aspirin. He had measles during the early part of June, 1941, from which recovery was supposedly uneventful. The habits of the patient were good except that he refused to eat when ill. The family history was not unusual.

Physical examination revealed a fairly well developed and a well nourished negro child. Head, neck, eyes, ears, and nose were essentially negative. Lungs were normal. On admission a loud systolic murmur was heard in all the valve areas with the greatest intensity

at the apex. An occasional extrasystole was heard. The heart was normal in size and position. The abdomen and the genitalia were essentially negative. The left knee felt warm, was markedly tender on palpation, and considerable pain was caused by attempted motion. A small discolored area about $\frac{1}{2}$ cm. in diameter was noted on the medial aspect of the left leg at the level of the inferior border of the patella. The latter was not considered significant at the time. Reflexes were hyperactive. The temperature was 104°F., pulse 130, and the respirations 30 per minute. Blood count showed 3,560,000 red blood cells, and 12,050 white blood cells per cu. mm. with 71 per cent hemoglobin. Differential showed 86 per cent neutrophils. The sedimentation rate was 19 mm. in one hour. The Wassermann reaction of the blood was negative. Except for traces of albumin and sugar, the urinalysis was essentially negative. The diagnosis at this time was acute rheumatic fever.

On the day of admission the patient was given an enema, placed on a liquid diet, and received 10 gr. of aspirin. On July 24th, large wheals were noted over the right side of his face. It was believed that this was an allergic reaction, and the aspirin was discontinued. Adrenalin (4 m.) was given followed by the same dose fifteen minutes later. In less than two hours the wheals disappeared. Temperature dropped to 103°F., pulse 130, and respirations increased to 40 per minute. Stools were soft, brown in color and positive for blood. The patient received 30 gr. of sulfathiazole and an order was left for 7½ gr. sulfathiazole every four hours until temperature remained normal for thirty-six hours. On July 25th, an erythematous rash was noted over the entire body, the tonsils and throat appeared injected, the left knee was swollen and more painful with some evidence of induration in the region of discolored area. The tuberculin test was negative. Examination showed no evidence of

* From the surgical service of Provident Hospital, Baltimore, Md.

any systolic murmur and no evidence of any extrasystole at this time. Heart findings were normal except for rapid rate. Temperature at

10 gr. of sodium bicarbonate every four hours was ordered. A hypodermoclysis of 500 cc. of normal saline was given.



FIG. 1. Posterior view of the heart showing the area of rupture in the left ventricle near its junction with the left auricle.



FIG. 2. Section through the left ventricle wall showing extent of the abscess in its upper part. The external opening plugged by a blood clot and the ragged appearance of the endocardium in the region of the internal rupture can be easily made out.

one time reached 104.8°F., pulse 168, and respirations 42 per minute. Blood count showed 3,600,000 red blood cells, 25,100 white blood cells, with 71 per cent hemoglobin. The differential showed 88 per cent neutrophils. The patient became more delirious and had to be restrained. Tepid baths were ordered. Sulfathiazole was discontinued after two doses. Sulfanilamide (30 gr.) was given at 3:50 P.M., and sulfanilamide (5 gr.) was ordered four times a day.

On July 26th, the temperature ranged between 103.2° to 101.6°F. going down to 100.4°F. at midnight. The patient was quite restless, pulse rate remained above 120 and respirations between 30 and 60 per minute. Blood count showed 3,380,000 red blood cells, 18,500 white blood cells, with 78 per cent hemoglobin. There was marked evidence of edema of the tissues about the left knee joint, which was very warm and markedly tender. The abdomen was also tender on palpation. The erythema noted over the body, the face, and the extremities presented some bizarre shapes. After two doses of sulfanilamide (5 gr.) were given the order was discontinued, and sulfanilamide (10 gr.) with

On July 27th, surgical consultation was sought. At this time the abdomen was found to be slightly distended. The left knee was swollen and tender. No surgical measures were instituted. Temperature on this day dropped to 99.2°F., at 4 A.M. and rose steadily to 103.4°F. at 12 noon. Pulse remained above 120, and respirations between 30 and 42 per minute. Sulfanilamide with sodium bicarbonate was discontinued and 10 gr. of sodium salicylate with 10 gr. of sodium bicarbonate was ordered every four hours.

On July 28th, the general appearance of the patient had not changed. The temperature was 102°F., pulse remained above 120, with respirations 50 per minute. Blood count showed 18,500 white blood cells and 64 per cent hemoglobin. A blood culture at this time showed a forty-eight-hour pure culture of *Staphylococcus aureus*. Following the latter report, the sodium salicylate was discontinued and 5 gr. of sulfanilamide three times a day was ordered.

On July 29th, the condition of the patient remained the same.

On July 30th, blood count showed 4,100,000 red blood cells, 22,600 white blood cells, with 81 per cent neutrophils, and a hemoglobin of 71 per cent. The patient was transferred to surgery because of extensive cellulitis about and below the left knee. A small amount of yellowish purulent material exuded from a small opening at the medial aspect of the left knee at the level of the inferior portion of patellar bone. The inguinal glands were swollen and tender on palpation. A diagnosis of acute osteomyelitis was made and an x-ray of the left knee was ordered. Temperature remained around 103°F., pulse above 130, and respiration about 40. The patient became quite incoherent and sulfanilamide was discontinued on July 31st. X-ray showed no demonstrable evidence of any bone disorder.

On August 1st, the temperature ranged between 101°F., and 103°F., pulse above 120, and respiration between 30 and 40 per minute. Scattered râles were heard in both lung fields. Heart findings were normal. The opening over left knee seemed larger and more pus was escaping.

On August 2nd, the child's condition remained about the same. On August 3rd, the general condition seemed improved except for some swelling and tenderness of the fourth finger of the left hand.

On August 4th, warm boric acid compresses were applied to the left leg continuously. A large ulcer 2 cm. in diameter extending down to the periosteum of the bone was noted in the position of the discolored area first seen on admission. The patient was quite restless during the night. At 3:25 A.M. on the morning of August 5th the patient asked the nurse on duty for a drink of water. After he drank the water, the nurse returned to her desk about twenty-five feet away, picked up a tray to go back to the patient's bed. On reaching the bed the nurse noted that the patient was apparently lifeless. Death had taken place almost instantaneously.

Postmortem examination revealed the following: A large ulcer with a diameter of 3 cm. was noted at the level of the inferior border of the patella bone on the medial aspect of the left leg. The edge of the ulcer was ragged and showed evidence of extensive necrosis of tissue. The ulcer extended to the periosteum that

was somewhat thickened and not raised. The bone showed no macroscopic evidence of any pathological condition. Incision through the soft tissue along the tibia revealed numerous pus pockets between the muscle sheaths and the periosteum. Purulent fluid was noted in a channel along the medial border of the tibia outside the periosteum extending to the lower third of the leg. It followed the lines of least resistance in the fascial spaces.

The pericardial sac was markedly distended. The parietal surface was ragged in appearance and discolored. Numerous adhesions were noted between the pericardial sac and the lungs. The pericardium was thickened and the sac contained about 300 cc. of fluid blood and blood clot. The blood clots were both of chicken fat and of currant jelly type. The visceral pericardium was rough and discolored with old organized blood, which was removed from the serous surface with difficulty.

The heart weighed 180 Gm. The epicardium was covered with a ragged material resembling organized blood that was removed with the greatest difficulty. The epicardium was studded with abscesses both small and large that followed the vascular distribution over the heart. A rather large opening plugged by a blood clot was noted on the posterior aspect of the left ventricle just beneath the coronary sulcus. A probe was easily passed through this opening into the left ventricle. The internal opening was beneath the posterior mitral cusp. On insertion of the probe a yellowish pus escaped from the abscess cavity. Section showed that the abscess had spread in several directions from a central focus with only a thin layer of muscle fibers intact on either side. Adherent old blood clots were removed with difficulty from mitral valve leaflets revealing grossly normal structures.

The lungs were adherent to the chest wall, and nodular in appearance due to large peripheral abscesses. Pus was noted in pleural cavities. Several of the abscesses had ruptured into the pleural cavity. Many of the larger abscesses had coalesced. Numerous minute abscesses seemed to follow the course of the smaller blood vessels over the periphery of the lungs. Section revealed abscesses scattered throughout the substance of the lungs, with the larger abscesses near the surface. Some abscesses were multilocular while most were single and discrete. The abscess walls were

friable and contained a cheesy purulent substance. The largest abscess measured 2 cm. in diameter.

The spleen weighed 160 Gm. The organ was

Several palpable posterior and lateral cervical glands were noted on the left side of the neck. Tonsils were removed for histological study. The head was not examined.



FIG. 3. Microphotograph showing a part of a large abscess of lung just beneath the visceral pleura covering the lung. Some of the necrotic tissue can be seen within the abscess cavity. $\times 8.7$ (Van de Grift's fixative).

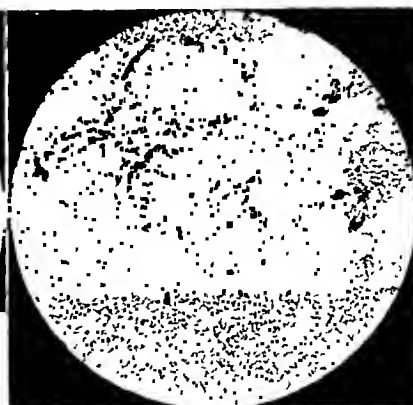


FIG. 4. Microphotograph showing numerous small abscesses of the lung with the replacement of normal tissue by collections of inflammatory cells and debris. Collections of serum within many of the bronchioles and alveolar spaces can be seen in places. $\times 87$. (Van de Grift's fixative).

soft and greyish pink in color. The pulp protruded from the cut surface, but could not be wiped away with the knife.

The liver weighed 600 Gm. It was bound to the diaphragm in places by dense adhesions. The capsule was rather adherent. One large abscess was noted over the superior surface of the right lobe of the liver and ruptured when adhesions between the liver and diaphragm were broken up.

The pancreas and the gastrointestinal tract did not show any marked gross pathological disorder except for petechial hemorrhages scattered over the mucosal surface of the stomach and the small intestines. These hemorrhages followed the blood supply. Practically all of the lymph glands seen were enlarged and palpable.

Both kidneys were enlarged. The capsules were removed with difficulty. Numerous small yellow abscesses were noted over the surface of the kidneys. In the cortex of the right kidney an abscess with a diameter of 0.2 cm. was noted on the anterior surface near the lateral border. The medullary portions of the kidney showed fewer abscesses that were pin-point in size.

A well organized thrombus was noted in the descending aorta near its bifurcation. It extended into the left common iliac artery.

Culture of some purulent material from several of the abscess cavities and from the blood in the cardiac cavity revealed a pure culture of *Staphylococcus aureus*.

Microscopic examination showed marked infiltration of neutrophils in the myocardium surrounding the ruptured area, with necrosis of adjacent heart muscle. Thrombi in several of the small vessels showed neutrophils and macrophages. The lungs, spleen, liver and kidneys also showed findings typical of an extensive pyemia. The periosteum at the base of the ulcer showed evidence of necrosis and numerous foci of neutrophils, lymphocytes and macrophages. Section of bone beneath showed widely scattered foci of inflammatory cells. Tonsils showed chronic tonsillitis and also evidence of a recent acute infection. The peritonsillar musculature showed some evidence of fibrosis. Crypts showed little evidence of desquamation of their epithelium. No evidence of any thrombi noted within the lumina of small blood vessels in the peritonsillar tissue. Section through the ulcer showed marked diffuse neutrophilic infiltration with extensive cloudy swelling and necrosis of tissue. The smaller vessels were occluded by thrombi that contained neutrophils, lymphocytes and macrophages.

COMMENT

Abscess of the heart with rupture is a rare condition. It is usually a metastatic

eleven hours. It seems likely that the rapidity of death depends to some extent upon the size of the rent and on the manner

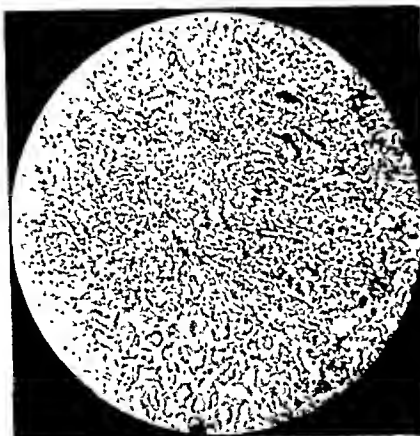


FIG. 5. Microphotograph showing an abscess of the kidney with inflammatory cells infiltrating all adjacent tissue. The glomerular tufts show numerous inflammatory cells invading the capillary walls and their lumina. The greater accumulation of cells is about the arterioles in the region of the tubules adjacent to the glomeruli. $\times 87$ (Van de Grift's fixative).

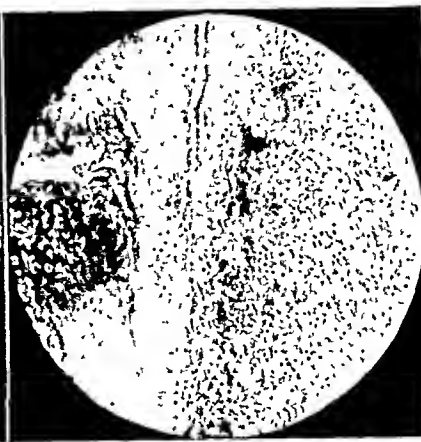


FIG. 6. Microphotograph of section of the myocardium showing infiltration of muscle tissue by inflammatory cells and areas of necrosis. Section was taken in region of the rupture. $\times 87$ (Van de Grift's fixative).

manifestation of an overwhelming sepsis. In the older reports there are gross descriptions of the heart with little or no information on the clinical course or the bacteriology.

It is almost certain, as was maintained by Morgagni, that a rupture never occurs in a sound heart muscle, the most frequent cause being fatty degeneration or infiltration of the muscles, and occlusion of the coronaries. Less commonly, myomalacia, abscess, gumma, echinococcus cysts and new growths are responsible.

According to Claytor, probably in more than 70 per cent of the cases of spontaneous rupture of the heart, death is instantaneous; but there may be a sense of anguish in the cardiac region with a feeling of suffocation and life may be prolonged for several hours. Osler speaks of seeing a case in which the patient walked up a steep hill and lived for thirteen hours after the rupture occurred, and there is one case, at least, in which the patient survived for

in which the muscle fibers are separated, i.e., whether the entire thickness of the wall gives way at once or by degrees. Death results from shock or from pressure produced by the overdistended pericardium.

An abscess of the myocardium might rupture into the pericardial sac or into the cavities of the heart, or both. Howitt, in 1846, reported the postmortem findings on a boy, age eight years, who went gradually into coma. It could be assumed that the cause of his ailment was some septic condition. The pericardium was distended and a pint of pus was found in the sac. At the junction of the right auricle and ventricle an abscess was incised containing a dram of pus. The abscess cavity communicated with the right auricular cavity. Whether or not the abscess opened into the pericardium was not stated. Moxon, in 1869, described the case of a boy, age eleven years, who suffered from high fever and delirium. Physical examination of the chest was not made. At postmortem turbid fluid was found in the left pleura. There was an acute fibrinous pericarditis. Several small abscesses were located in the myo-

cardium. One of these had ruptured into the left ventricle. Similar abscesses were found in one kidney and in the bones. The etiology of sepsis in this case was not determined. Haddon, in 1884, published a case of a boy, age six years, who had fallen from some railings, and who complained of pain and swelling of the left foot. Some months later an ulcer developed on the outer side of the left ankle, and two weeks later the patient was admitted to the hospital with signs of pneumonia. Two days after admission he asked to be propped up in bed, gasped and died suddenly. At postmortem there were pyemic abscesses in the liver and kidneys; there was a pericarditis, and the heart had ruptured on the posterior wall of the left ventricle near the auricle. It was never determined finally that there was an actual abscess in the wall. Formad, in 1893, showed a specimen of the heart of a man who died suddenly while diving. In the left ventricular wall posteriorly an abscess was found about the size of a large bean. The pericardium contained seropurulent fluid. Over the pericardial surface several areas of ecchymosis were present. The etiology of the abscess was not determined. Rudolf and Moorhouse, in 1916, reported the case of a soldier, aged twenty, who entered the hospital with normal heart findings, and as a sequence and complication of a single shrapnel wound of the left chest involving the pleura and lung, an abscess formed in the interventricular septum. Subsequently, a short systolic "swish" and a marked, rough diastolic bruit was heard over the second and third costal spaces on the right, close to the sternum. A diastolic thrill was palpated over the same area. At postmortem the pericardium was found to contain a considerable amount of yellowish fluid. The visceral and parietal layers were covered with a fibrinous deposit. A flattened mass of fibrin was lying free near the apex. This mass had the appearance of a partially resolved blood clot. The pericardium was intact. On the inner wall of

the right ventricle, whose cavity was greatly dilated, an ulcerated patch was found extending anteriorly from near the medial and anterior leaflets of the tricuspid valves, and burrowing into the wall of the septum was a sinus which opened into the right ventricle near the base of the medial leaflet of the pulmonary valve. There were two openings of the abscess channel in the right ventricle which extended on to the tricuspid and semilunar valves. Burrowing directly through the septum the abscess channel opened into the systemic aorta under cover of the anterior leaflet of the aortic semilunar valve. There was as a result a communication between the systemic aorta and the right heart, with consequent leakage from the aorta into the right ventricle. No bacteriologic examination was attempted.

Goodall and Weir analyzed a series of eighteen cases of rupture of the heart, one being the result of gummatous infiltration of the wall, and the others the result of disease of the coronary arteries.

Stevenson and Marshall, in 1928, reported the case of a boy, aged nine years, who was struck by a stone on the medial aspect of the left ankle. Three days afterward blebs appeared at the site of trauma and the ankle became swollen. Poultices were applied but the condition did not improve. The boy became very ill, and began to vomit on the day prior to admission. Diagnosis on admission was osteomyelitis although there were no obvious signs of bone inflammation. An urgent operation was performed with free incisions into the cellulitic area over the fibula. The subcutaneous tissues were infiltrated with thin, watery pus which was clinically streptococcal in type. Periosteum over the fibula was not raised or much inflamed, and there was no evidence of osteomyelitis of the bone. Following the operation the boy developed numerous swellings in various situations, notably in the abdominal wall and in the parotid regions. Some dullness was noted over the base of the left lung

thirteen days after admission, although the boy appeared to be improving. On the morning following admission, the temperature had dropped to normal, and his pulse, which had been uncountable in the earlier days of his illness was 120. The nurse in charge went in to ask him what he wished for his breakfast, and was informed that he wished an egg. On returning with this a few minutes later she found that he was dead, death having been practically instantaneous. Postmortem examination showed a fibrinous pericarditis of some duration, with the pericardial sac distended with a mixture of fluid blood and pus. On raising up the heart, a small portion of a blood clot was seen to be adherent to a ruptured abscess on the posterior wall of the left ventricle midway between the apex and base. There was a second abscess which had also ruptured toward the base of the left ventricle posteriorly, and a third was present in its anterior wall. The lower of the two posterior abscesses had ruptured both internally and externally, while the other occupied almost the whole thickness of the ventricular wall, though there were still a few strands of muscle between it and the cavity. There was pus in both of the pleural cavities and both lungs were collapsed. Innumerable pyemic abscesses were present throughout the substance of both kidneys. Culture of the pus yielded a pure growth of *Staphylococcus aureus*.

McLagan, in 1928, reported a case of a fifty-seven year old male, who had suffered from boils and carbuncles in the region of his back and legs for four years prior to admission. After developing a large carbuncle that seemed to respond well to treatment, in the form of free drainage, he developed a generalized sepsis. In this illness he had a "seizure" and collapsed. Postmortem examination showed the pericardial sac filled with a soft clot. A small probe could be passed into the right coronary artery and into a small cavity containing about 1 cc. of pus. No bacteriological studies were made in the case.

Death was due to rupture of the abscess into one of the coronary arteries and the pericardial sac, giving rise to a condition which simulated, and was at first mistaken for cardiac rupture.

Krumbhaar and Crowell collected and analyzed 611 cases of spontaneous cardiac rupture, and abscess was mentioned in only three cases. Davenport analyzed ninety-two additional cases with only two as the result of abscess.

Cossio and Berconsky, in 1933, reported the case of a sixty-four year old man, who developed an abscess of the myocardium as a secondary process in a previously infarcted area caused by a primary coronary thrombosis. Three days before coming to the hospital he developed thoracic pain and respiratory difficulty. During his two weeks in the hospital the patient showed signs of bronchopneumonia. Circulatory collapse gradually supervened and he died. Postmortem examination showed a pneumococcic meningitis and a myocardial abscess containing pneumococci. The latter was localized within the old infarcts. It would seem that the infarcted area was thus predisposed to the formation of an abscess.

Weiss and Wilkins made a very interesting report on myocardial abscess with perforation of the heart. A large amount of the material from the same is included in this report. From the hospital necropsy records examined, abscess of the myocardium was noted in thirty-one cases, with bacteriologic data available in twenty-six. *Staphylococcus aureus* sepsis was responsible in twenty cases, pneumococcus in two, *Streptococcus viridans* in two cases, *Streptococcus pyogenes* in one, and meningococcus in one. In the thirty-one cases rupture as a result of the abscess occurred but twice. In the first case, the staphylococcic abscess of the heart probably originated from urinary sepsis. A seventy-three year old male patient for a year prior to admission had some difficulty in urination, occasional incontinence, day and night frequency and had become very

thirsty, taking two gallons of water daily. Postmortem examination showed a rupture of the abscess into the right ventricle as well as into the pericardial sac. In the second case, a seventy-eight year old woman, the myocardial abscess was a direct extension of a small mural pneumococcic vegetation, a complication of bronchopneumonia. In the latter case the abscess was localized in the fat tissue at the junction of the left auricle and left ventricle. This abscess ruptured into the pericardial sac. In neither case did the clinical course suggest sepsis and the unexpected cardiac perforation resulted in a fatal circulatory collapse.

In the case here reported, before the autopsy, mother stated that the child had struck his left knee against a projection on his bed about two weeks before she brought him to the hospital. He complained of pains in that knee from time to time afterward, but the mother saw no lesion and disregarded the incident. This information was not given upon admission of the patient to the hospital. The abscess of the heart was probably a metastatic process resulting from the infection in the region of the left knee.

The clinical signs and symptoms of myocardial abscess with rupture, as noted from the nine cases in the literature and the case reported here, vary considerably. The abscess is symptom free until its rupture that may cause precordial pain followed by circulatory collapse and death within a few minutes or within a few hours. The loud systolic murmur heard on the first day of admission and not heard thereafter is certainly questionable though possible. This case adds another to all of the reported cases of cardiac rupture due to an abscess none of which have been diagnosed clinically.

SUMMARY AND CONCLUSION

A case of myocardial abscess with perforation is described. The abscess caused by *Staphylococcus aureus* ruptured into

the left ventricle as well as into the pericardial sac. The clinical course following an injury to the left knee suggested sepsis, although this was not given much consideration on admission. The unexpected cardiac perforation caused the fatal circulatory collapse.

Although in cases of sepsis, abscess of the myocardium is not unusual, perforation of the heart as a result of an abscess, however, is quite rare. Nine cases collected from the literature are described. A diastolic murmur was heard in two of the ten cases. From the ten cases now available it is still possible to state that myocardial abscesses are symptomless until their rupture. At that time there may be precordial pain followed by collapse of the circulation.

From a theoretical point of view it would have been of interest to have learned the outcome of this reported case, if early free surgical drainage about the lesion on the left knee had been attempted, and adequate sulfonamide therapy instituted.

(I wish to express my appreciation for suggestions by Maj. Walter C. Merkel, M.C.-U.S.A., formerly at Union Memorial Hospital, Baltimore, Md., and by Dr. Charles R. Drew, of Department of Surgery, Howard University, Washington, D. C.; also for pictures of the heart made by Mr. Kougl, and for preparation of the microscopic sections by Mr. Walker, both in the pathology department of Johns Hopkins Medical School.)

REFERENCES

1. CLAYTOR, T. A. Spontaneous rupture of the heart in a case of ulcerative endocarditis. *J. A. M. A.*, 80: 1371-1372, 1923.
2. COSSIO, P. and BERCONSKY, I. *Semana méd.*, 2: 1691, 1933.
3. DAVENPORT, A. B. Spontaneous heart rupture—a statistical summary. *Am. J. Med. Sc.*, 176: 62-65, 1928.
4. FORMAD, H. F. Abscess of the heart. *Tr. Path. Soc., Philadelphia*, 16: 80, 1893.
5. GOODALL, J. S. and WEIR, H. B. Rupture of the heart—an analysis of 18 cases. *Brit. M. J.*, 1: 834, 1927.
6. HADDON, W. B. Two cases of ruptured heart. *Tr. Path. Soc., London*, 35: 121, 1884.
7. HOWITT, T. Remarkable case of abscess of the heart. *Lancet*, 1: 684, 1846.

8. KRUMBHAAR, E. B. and CROWELL, C. Spontaneous rupture of the heart. *Am. J. Med. Sc.*, 170: 828-856, 1925.
9. McLAGAN, F. A case of abscess of the heart causing death through coronary hemorrhage. *Lancet*, 2: 279, 1928.
10. MOXON. Case of abscess of the heart bursting into the left ventricle. *Tr. Path. Soc., London*, 20: 113, 1869.
11. RUDOLF, R. D. and MOORHOUSE, V. H. K. Abscess of the myocardium resulting in aortic leakage into the right heart. *Lancet*, 1: 292, 1916.
12. STEVENSON, G. H. and MARSHALL, A. J. Rupture of the heart from pyemic abscess in the myocardium. *Glasgow M. J.*, 110: 337-340, 1928.
13. WEISS, S. and WILKINS, R. W. Myocardial abscess with perforation of the heart. *Am. J. M. Sc.*, 194: 199-205, 1937.



IN the large gaping wounds of the soft tissue of the face, one may be tempted to try closure early by suture. This should never be done before at least temporary fixation of bone fragments, otherwise collapse of the latter will occur, with great deformity and interference with function.

ANNULAR PANCREAS

ACCOMPANIED BY AN ABERRANT PANCREATIC NODULE IN THE DUODENUM

JEAN L. CHAPMAN

AND

H. W. MOSSMAN, PH.D.

Instructor in Anatomy, University of Wisconsin

Associate Professor of Anatomy, University of Wisconsin

MADISON, WISCONSIN

ANNULAR pancreas although considered a rare anomaly has been reported many times in medical literature. McNaught, in 1933, gave an excellent summary of thirty-nine cases that he had been able to trace in the past literature, and in addition reported a new one. In 1935, this same author reported another case and referred to three more in current literature bringing the total to forty-four. Since then the reports of Cunningham (1940) and Truelsen (1940) have appeared. This paper is to record the finding of still another.

This example of annular pancreas was found at the University of Wisconsin anatomical laboratory in the body of a fifty year old Greek male. The subject came from an institution where he had been committed for eleven years with dementia precox, hebephrenic form. The cause of death was diagnosed as cerebral apoplexy. No clinical history of the case was available but according to institution employees, this patient never suffered from any gastrointestinal disturbances.

Besides the annular pancreas several other anomalies were noted in this body. The spleen was two to three times the usual size. The gall-bladder was atrophied and embedded in fibrous tissue filling the fossa. A single stone about 16 by 22 mm. in size was present imbedded in fibrous tissue at the side of the contracted lumen. The latter was not connected with the space containing the stone. The common bile duct and accompanying vessels were enclosed within a very dense connective tissue, and the omentum and transverse colon near the right colic flexure were adherent to the liver. Two small hemangiomas were found on the liver. Both the ascending and descending colons had complete but short mesenteries. The appendix was 13 cm. long and extended in its own mesentery upward on the right of

the colon to the right colic flexure. The ascending colon and cecum together were only about 13 cm. long. The cecum was adherent and somewhat retroflexed.

An aberrant pancreatic nodule with a diameter of 15 mm. and a thickness of 10 mm. was found on the dorsal side of the duodenum 30 mm. below the pylorus. Pancreatic tissue, islet cells, and ducts which opened into a pit-like evagination from the lumen of the duodenum were observed on microscopic examination. The pancreatic tissue lay external to the muscularis mucosa while Brunner's glands were located internal to it around the pit-like opening of the pancreatic ducts. Otherwise the latter glands were located in the submucosa. Branch and Gross (1935) reported twenty-four cases of aberrant pancreatic tissue in the gastrointestinal tract and summarized the literature on about 200 other cases.

The pancreas itself was unusually large, measuring 170 mm. from the tail to the right side of the head. The band of pancreatic tissue completing the annulus was firmly fused with pancreatic tissue on both ventral and dorsal sides of the descending part of the duodenum. It measured 20 mm. in width in front of the duodenum and fanned out on the left side of the latter structure to a width of 45 mm. The length of the lobe making up the band was 100 mm., measured from its origin on the right side of the duodenum to its left ventral termination. This structure definitely constricted the duodenum, and both cephalic and caudal to the ring, the latter was dilated.

The duct system of this pancreas when dissected out revealed that the duct from the annular portion joined the main duct of Wirsung just before the latter entered the common bile duct. Several ducts from lobes in the region of the head were found to contribute branches to the main pancreatic duct dorsal to the duodenum. What was probably a small accessory duct of Santorini was also observed connecting the main duct in the neck to the duo-

denal wall in the usual position. However, no lesser ampulla could be located nor could a patent duct orifice be demonstrated by injec-

McNaught (1933) have discussed these. A persistence of the left ventral pancreatic bud is thought by the authors to best

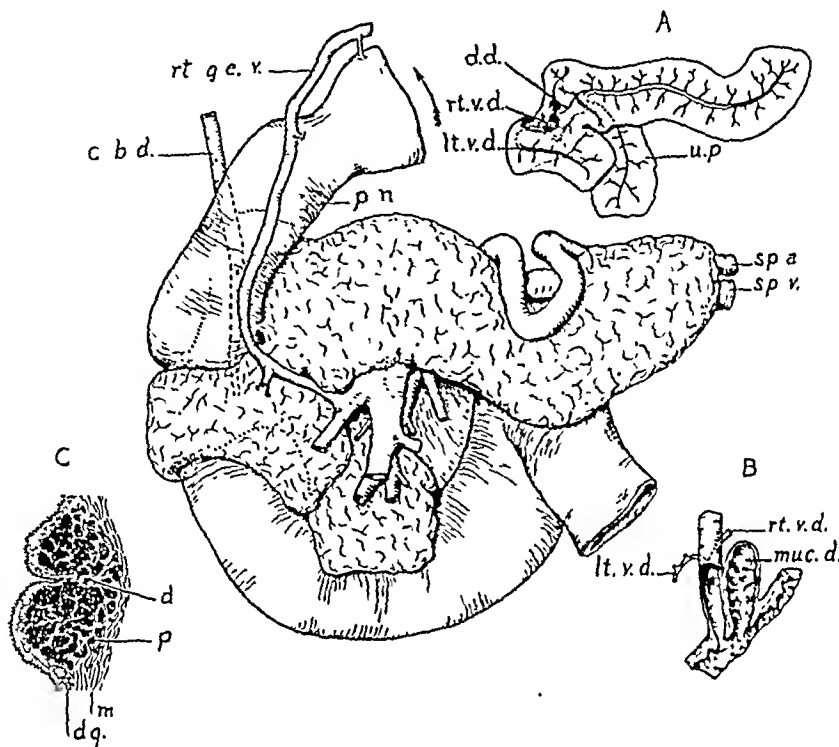


FIG. 1. Ventral view of ring pancreas showing relation to duodenum and superior mesenteric and splenic vessels. First part of pylorus and duodenum rotated upward as indicated by arrow. Mesenteries and superior pancreaticoduodenal vessels not shown. A, diagram of pancreatic ducts. B, duodenal end of the common bile duct and the proximal portions of the right and left ventral pancreatic ducts, showing their relation to the mucosal diverticulum and the wall of the duodenum. There was no papilla major. C, diagram of a section through the pancreatic nodule in the wall of the first part of the duodenum. (Main figure is one-half actual size; others not drawn to scale.)

c, b, d, common bile duct; d, duct in pancreatic nodule; d. d., dorsal pancreatic duct (accessory or Santorini's); d. g., duodenal glands (Brunner's); lt. v. d., left ventral pancreatic duct, the one normally absent; m, muscle layer of duodenum; muc. d., mucosal diverticulum; p, pancreatic tissue; p. n., location of pancreatic nodule in duodenal wall; rt. g. e. v., right gastro-epiploic vein, continued below as the inferior pancreaticoduodenal; rt. v. d., right ventral pancreatic duct (main or Wirsung's); sp. a., splenic artery; sp. v., splenic vein; u. p., probably a much enlarged uncinate process.

tion. Of special interest, too, was the lack of an ampulla of Vater. A mucosal diverticulum in the duodenal wall, 20 mm. in length, located just cephalic to the opening of the common bile duct was noted, but this had no connection with the latter structure. Islet tissue was present in the proximal, middle and distal portions of the annular lobe (left ventral), and also in the much elongated uncinate process.

There have been several theories advanced as to the cause of annular pancreas. Baldwin (1910), Howard (1930), and

explain the origin in this case. It is unnecessary and unreasonable to assume the "fixation" of the left ventral bud before rotation of the duodenum to account for the ring, as Lecco (1910) has done. Since the duodenum has such a small diameter relative to the thickness of its ventral and dorsal mesentery at the time the ventral bud contacts the dorsal (10 mm. embryo), there is every reason to believe that in these cases the ventral pancreatic tissue simply spreads dorsally in a subperitoneal

position around both sides of the duodenum, instead of around one side as in normal cases. In fact this condition with three pancreatic ducts and lobes is the normal one in birds (Hill, 1926 and Siwe, 1927).

SUMMARY

1. A case of annular pancreas was found in a fifty year old male.
2. An aberrant pancreatic nodule was present in the duodenum.
3. Islet tissue was present in the annular lobe, in the greatly elongated uncinate process, and duodenal nodule.
4. Other congenital anomalies were a free ascending and descending colon and hemangiomas of the liver.
5. Pathological conditions noted were an atrophied gallbladder with a single stone, an enlarged spleen and adhesions between the liver and transverse colon.
6. The most logical explanation for these cases seems to be a persistence of the left

as well as the right ventral pancreatic buds.

REFERENCES

1. BALDWIN, WESLEY M. A specimen of annular pancreas. *Anat. Rec.*, 4: 299-304, 1910.
2. BRANCH, C. D. and R. E. GROSS. Aberrant pancreatic tissue in the gastro-intestinal tract. *Arch. Surg.*, 31: 200-224, 1935.
3. CUNNINGHAM, G. J. Annular pancreas. *Brit. J. Surg.*, 27: 678-681, 1940.
4. HILL, W. C. OSMAN. A comparative study of the pancreas. *Proc. Zool. Soc. Lond.*, pt. II: 581-632, 1926.
5. HOWARD, N. J. Annular pancreas. *Surg., Gynec. & Obst.*, 50: 533-540, 1930.
6. LECCO, T. M. Zur Morphologie des Pancreas Annulare. *Sitzungsab. d. k. Akad. d. Wissensch., Math.-naturw. Kl.*, Wien, 119: 391-406, 1910.
7. McNAUGHT, JAMES B. Annular pancreas. A compilation of 40 cases, with a report of a new case. *Am. J. Med. Sc.*, 185: 249-260, 1933.
8. McNAUGHT, JAMES B. and ALVIN J. COX. Annular pancreas, report of case, with a simple method for visualizing the duct system. *Am. J. Path.*, 2: 179-184, 1935.
9. SIWE, STURE A. Pankreasstudien. *Morph. Jahrbuch*, 57: 84-307, 1927.
10. TRUELSEN, F. Annular pancreas. *Nord. Med. (Hospitalstid)*, 8: 2226-2231, 1940.



ANORECTAL PAIN DUE TO FOLLICULAR OVARIAN CYST

H. LEONARD BOLEN, M.D.

Head of Department of Proctology and Gastroenterology, Fall River General Hospital

FALL RIVER, MASSACHUSETTS

ANORECTAL pain is a very common and very distressing complaint. Sometimes the cause can be readily determined during a routine rectal examination; but more often the etiology is obscure and a very careful investigation is necessary before an organic basis can be found. Buie and Brust¹ reported a series of 100 cases of high rectal pain in which the cause was undetermined in seventy-one. Rectal neuralgia was considered the causative factor in 14 per cent of the cases, chronic nervous exhaustion in 26 per cent, and psychoneurosis in 12 per cent. In 19 per cent the cause was not found.

The problem is equally confusing in dealing with cases of anorectal pain. This is not surprising when one considers the wide variety of causes. Gerendasy² recently listed the following factors: constipation, foreign bodies, hemorrhoids (thrombosed, strangulated, ulcerated, prolapsed), anal and rectal fissure, fistulas, strictures, cryptitis, papillitis, abscesses; acute inflammation of adjacent structures; gynecological causes such as retroversion, acute Bartholinitis, salpingitis, oöphoritis, perineal tears, abscess in the pouch of Douglas and endometriosis. Daniels,³ Graham,⁴ Lockhart-Mummery,⁵ and others, therefore, caution against calling anorectal pain neuralgia or nervous proctalgia, when a true pathological cause can be discovered. For example, referred rectal pain is a common symptom in the general run of gastrointestinal cases, in cystitis, prostatic disease, sciatica, epilepsy, and tabes dorsalis.

The correct diagnosis of anorectal pain presupposes an accurate knowledge of the nerve supply of this region. The anus and rectum are supplied by the second, third, fourth and fifth sacral nerves and the coccygeal plexus. Sympathetic fibers from

the hypogastric and the pudendal form a plexus above the level of the levator ani muscle. Thus, the nerve supply of the anus, anal canal, and rectum comes partly from the cerebrospinal and partly from the sympathetic system. The anal canal in the region of the pectinate line and below is abundantly endowed with sensory nerves, and thus the area is extremely sensitive.

The anal sphincter is a law unto itself. Irritation of the sympathetic system causes it to contract, and the only force which will relax it spontaneously is the downward progress of the proper peristaltic wave. The reflexes are numerous and far-reaching, and herein lies the answer to the kaleidoscopic clinical syndromes and clinical surprises in the anorectal region.⁶ To quote from Graham:⁴

"An enlarged prostate due to inflammation, hypertrophy or abscess formation, by a downward extension causes painful anorectal sensations. It may be merely a sense of weight or uneasiness, or it may be a most annoying and painful tenesmus. The unyielding character of the prostate sheath, and the nerve supply to the gland, explain the heavy throbbing that is experienced so frequently in the rectum. . . . The intimate connection of the sensory nerves of the pelvic organs with those of the anorectal tissues explains these referred painful sensations."

A large fibroid pressing against the rectal wall may cause severe pain in the anal region. Thus, careful proctological, urological and gynecological examinations must be carried out in all puzzling cases of anorectal pain.

Hill⁷ discusses a group of cases in which anorectal pain was associated with organic disease of the nervous system, with pressure on the pelvic plexus by an expanding

growth, with disease of the pelvic bones, coccygodynia and sacroiliac disease.

The case reported below illustrates the difficulty of arriving at the correct diagnosis when the cause of the anorectal pain was extrarectal.

CASE REPORT

H. H., a white female, forty-three years old, single, a nurse by profession, was first admitted to the hospital October 27, 1936, for repeated attacks of lower abdominal pain and rectal spasm. During these attacks she was unable to pass gas and had great difficulty in moving her bowels. This condition had persisted for four years. Attacks occurred each month just before menstruation. The abdominal pain and anal spasm diminished as soon as menstruation started. The anorectal pain was less severe when the period was retarded or irregular. The patient complained of inability to push out the rectal contents. The lower bowel seemed to become filled with gas, distending the lower portion of the abdomen. Cathartics failed to relieve the pain. For the last two years, the stools contained mucus and purulent-looking material. At times, a well formed stool was seen coated with thick mucus. Mild diarrhea was present at intervals and blood was observed in the stool on one occasion. The patient reported a loss of eighteen pounds in the past four years.

At the age of fifteen years the patient was operated upon for an acute appendicitis. At this time the right ovary was found to be cystic, enlarged and flabby and was removed.

Tonsils and adenoids were removed and a submucous resection performed for deviated septum in June, 1930. The patient had a proctoscopic examination for rectal spasm and pain October 21, 1935. No diagnosis was made after this examination.

The patient's father died of carcinoma of the stomach. One sister died of carcinoma of the breast. There was no family history of any other chronic diseases.

Physical examination revealed tenderness on deep pressure over the entire lower half of the abdomen, more marked on the left. No mass was felt. It was impossible to insert a finger into the anus because of its tight, unrelaxed condition. The patient complained of severe pain when any such attempt was made. Ex-

amination under gas-oxygen-ether anesthesia revealed a uterus enlarged to twice normal size with a subserous fibroid of moderate size on the anterior wall. No pathological disorder was found in the rectum. The patient decided against operation and was discharged untreated.

Attacks of anorectal pain recurred. With the background of carcinoma in the family, the patient had in mind the possibility of cancer of the rectum and became increasingly nervous and unstable. She returned to the hospital February 4, 1937. X-ray examination on February 6th showed no organic disorder of the colon or rectum. Several times during the filling of the colon with the barium enema there was marked spasm of the descending colon accompanied by pain sufficient to cause the patient to cry out. A film taken after evacuation showed good emptying.

The examination of urine and blood showed nothing abnormal. The Kahn test was negative. The Benzidine test for occult blood in the stool was slightly positive. Cultures showed no non-lactose fermenting organisms.

On February 10, 1937, the abdomen was opened by a midline suprapubic incision under avcrtin-ether anesthesia. There was no free fluid present in the abdominal cavity. The gall-bladder was small, bound down in its fossa, but emptied well. The right ovary and tube and the appendix were absent. The uterus was normal in size and showed no pathological condition. It was in first degree prolapse. The left ovary was enlarged and contained a cyst the size of an orange which was lodged in the pouch of Douglas adjacent to rectum and anus. The cyst was excised and anterior fixation of the uterus done. The pathological report was as follows:

The ovary measured 5 by 4 by 2 cm. and was enlarged by the presence of numerous cysts which contained clear fluid. The largest cyst measured 3 cm. in diameter. The stroma was somewhat edematous. There was no evidence of any lutein bodies.

Microscopically, the stroma showed much edema. Most of the cystic cavities were lined by stratified epithelium. There were numerous corpora albicantes, a few of which had a degenerated center.

Diagnosis: Follicular cysts of the ovary.

The patient made a satisfactory convalescence and was discharged from the hospital February 22, 1937, twelve days after operation.

It is now more than six years since operation, and the patient has been symptom-free to date.

COMMENT

It is unfortunate that in this case the correct diagnosis was not made and the proper treatment not instituted until four years after the onset of the anorectal pain. It is important to bear in mind the fact that a tight, unrelaxing anal sphincter may be entirely the result of some disturbance outside the anal canal; in this case an ovarian cyst in the pouch of Douglas exerted pressure on the rectum and anus. The fact that the pain was always more intense just before menstruation did not offer a clue to the etiology. Bacon,⁸ however, points out the fact that in rectal and rectovaginal endometriosis pain is always intensified during menstruation.

In the case reported the anorectal symptoms of which the patient complained seemed to be out of proportion to the apparent cause. Even under general anesthesia, with marked relaxation of the sphincter muscle, examination failed to reveal the presence of the ovarian cyst in the pouch of Douglas. The assumed presence of a fibroid uterus seemed insignificant as a causative factor.

In this case the history was significant. The persistent anal spasm, repeatedly diagnosed as neurasthenia, persisted until

the beginning of the menstrual period. This spasm had produced a tight, unrelaxed anus. Pressure on the rectum by the cyst caused tenesmus, marked constipation, a sensation as of a foreign body in the rectum, and severe pain in both abdomen and lower sacral region.

Inasmuch as reports of anorectal pain resulting from pressure due to an ovarian cyst in the cul-de-sac of Douglas are few, this case was thought worthy of report. The intimate relation of the sensory nerves of the pelvic organs with those of the anorectal tissues should be kept in mind in the differential diagnosis in cases of anorectal pain.

REFERENCES

1. BLUE, L. A. and BRUST, J. C. M. High rectal pain—analysis of 100 cases. *Am. J. Digest. Dis.*, 1: 591-594, 1934.
2. GERENDASY, J. Anorectal pain, its causes and treatment. *J. Med. Soc. New Jersey*, 39: 21-26, 1942.
3. DANIELS, E. A. Rectal pain. *Internat. Clin.*, 3: 72-85, 1940.
4. GRAHAM, A. B. Anorectal pain. *Tr. Am. Proctol. Soc.*, 29: 57-64, 1929.
5. LOCKHART-MUMMERY, P. Diseases of the Rectum. 1st ed., pp. 250-256. New York, 1914. William Wood and Company.
6. BEACH, W. M. Some reflexes due to anorectal and colonic diseases. *Tr. Am. Proctol. Soc.*, p. 191, 1920.
7. HILL, M. R. Rectal pain in cases of sacro-iliac strain. *Tr. Am. Proctol. Soc.*, 37: 136-144, 1936.
8. BACON, H. E. Anus, Rectum, Sigmoid Colon, Diagnosis and Treatment. 2nd ed., ch. 11, p. 50. Philadelphia, J. B. Lippincott Company.



VOLVULUS OF THE CECUM AND ASCENDING COLON*

WITH A REVIEW OF THE LITERATURE AND PRESENTATION OF A CASE

MILTON ROTHMAN, M.D.,

Resident Surgeon and Pathologist, Harlem Hospital

JOHN P. BRUCKNER, M.D.

Associate Surgeon, Harlem Hospital

AND

DOMINICK F. ZETENA, M.D.

Associate Surgeon, Harlem Hospital

NEW YORK, NEW YORK

WHEN one considers the embryology of the intestinal tract, it is surprising that volvulus of the cecum and the terminal portion of the ileum does not occur more commonly. The first such case was described by Rokitansky¹ in 1841. Sweet² in reviewing the cases of acute intestinal obstruction at the Massachusetts General Hospital from 1873 to 1930, found only six in a series of 520 cases. This series did not include strangulated external hernia. European writers notably Du Roux,³ and Gatellier,⁴ aver that this condition is found more frequently in Russia, Finland, Poland and in Scandinavia. Pratt and Fallis⁵ stated that volvulus of the cecum is responsible for not more than 5 or 6 per cent of all cases of intestinal obstruction. In 136 cases of acute intestinal obstruction in the records of the Mayo Clinic,⁶ there is one case of volvulus of the cecum.

A study of the last 150 cases of acute intestinal obstruction at Harlem Hospital disclosed six cases of volvulus. Of the latter, one case revealed volvulus of the cecum and ascending colon.

Torsion of the right side of the colon is dependent upon incomplete fusion of the peritoneal layers of these parts. During the embryonal development of the abdominal dorsal mesentery, the cecum migrates from its abode in the left lower quadrant toward the left upper quadrant across the epigastrium and eventually to its final resting place in the right lower quadrant. As part of the final process, the cecum be-

comes fixed in this site by more or less complete fusion of the peritoneal layers of the ascending colon and cecum. These movements of (1) rotation, (2) descent, (3) fusion of the ascending colon to the posterior abdominal wall may be interrupted at any point, resulting in a developmental variation of the colon. In the course of its rotation the intestinal tract turns 270° anticlockwise about the axis of the superior mesenteric vessels. Of these anomalies, the most common is secondary to failure of fusion of the ascending colon resulting in this structure having a mesentery. As a result of this factor, the mobility of the colon is increased and renders this portion of the intestinal tract susceptible to torsion.

The incidence of occurrence of ascending mesocolon varies considerably as evidenced by reports of Chalfonte⁷ 20 per cent Treves⁸ 26 per cent Smithe⁹ 32 per cent and Harvey¹⁰ 13 per cent. This anomaly is found more frequently in women. It is interesting to observe the frequency with which ascending mesocolon and incomplete rotation of the large intestines are reported in conjunction with retroperitoneal hernias. Volvulus of the right colon is less common than volvulus of the left colon due to the fixation of the right colon normally.

It is agreed that torsion of the intestines upon its mesenteric border must be of at least 180° since pathological changes rarely begin before that stage is reached. The torsion is usually opposite that in which

* From the Surgical Service of Dr. Ralph Young, Harlem Hospital, New York City.

the gut normally rotates. Weible¹¹ reported the torsion to be clockwise in thirty out of thirty-seven cases. Complete colonic obstruction as produced by a volvulus must be as Wangensteen¹² has pointed out, considered as a closed loop obstruction. In nearly all such cases, the venous circulation is disturbed, and there is a tremendous passive congestion which gives way to hemorrhages first into the tissues of the intestines and then into the free peritoneal cavity. As the process continues, strangulation of the gut ensues.

The predisposing factors leading to volvulus of the cecum and ascending colon are: (1) Unusual length of the mesentery; (2) narrow base to the loop of the intestines; (3) a point of adhesion—inflammatory or congenital, at the convexity of the loop which can act as an axis of rotation.

The exciting causes are not well understood. With the above predisposing factors, the following have been suggested as possible precipitating causes: tumors, direct violence, overexertion (running, jumping, weight lifting), habitual constipation, fecoliths, foreign bodies and violent peristalsis (overeating, heavy purgation). Several cases have been reported during the course of pregnancy. Du Roux³ found volvulus to be common in those people eating coarse vegetable diets. Although ascending mesocolon is noted more frequently in women, volvulus occurs three times more frequently in the male sex. This may be secondary to effort or occupation. A review of the literature reveals that torsion may occur at any age. The youngest case reported is that of a child of four days old and was presented by Borow.¹³ However, the disease generally occurs between the third and fourth decade of life.

The symptomatology is essentially the same as that occurring in acute intestinal obstruction. The patient may give a history of several previous episodes associated with habitual constipation, generalized colicky abdominal pain, vomiting, obstipation and constipation, and rapid distention of the

abdomen. As pointed out in closed loop obstructions, tremendous distention usually takes place. This cannot be relieved by



FIG. 1. Scout film of volvulus of cecum and ascending colon.

vomiting, the Levine tube or enema. In the early phases violent peristalsis and increased tinkling may be heard on auscultation. With the progression of distention and compromise of the mesenteric blood supply, signs of peritoneal irritation, tenderness rebound tenderness, rigidity and paralysis of the intestines ensue. The temperature may be slightly elevated. If the patient is in shock the temperature may be subnormal. The leucocyte count is elevated with a marked shift to the left as a result of strangulation of the intestines and hemoconcentration. A rise in the leucocyte count may lead to an early diagnosis of strangulation. The count, however, should be correlated with the condition of the patient's hydration and the abdominal findings of peritoneal irritation. If small intestines are involved in the loop of the compromised gut, vomiting and signs of upper intestinal obstruction occur earlier than in uncomplicated colonic obstruction. However, the

progression of symptoms is much more rapid in a closed loop obstruction involving the cecum and ascending colon, than



FIG. 2. Film taken after two hours of decompression with Wangenstein suction.

in a simple obstruction of the colon. Chemistry studies reveal an elevation of urea nitrogen and low chlorides. The hematocrit shows hemoconcentration.

The diagnosis of a strangulated loop is made on the findings of an intestinal obstruction in association with signs of peritonitis. Roentgenograms are quite helpful in the diagnosis of volvulus of the cecum. Easton and Adams¹⁴ stated "when in the course of a barium enema, the column of barium is unable to pass beyond a certain point distal to the cecum, such as the ascending or transverse colon, (organic lesions being excluded), so that the cecum itself cannot be properly delineated in its haustral markings by the barium, and when at the same time a large collection of gas appears at the site of the cecum, either in the midline or slightly to the right of it, this is an indication that volvulus of the cecum has taken place." The barium serves the purpose of showing an obstruction in the large colon and distended gut, with or

without fluid levels will be revealed above this point. As for the diagnosis of volvulus of the cecum, a simple procedure has been worked out in the case we are presenting that may lead to a correct preoperative diagnosis. The observation has been helpful in making the diagnosis of closed loop obstruction both in the large and small gut.

X-rays, flat and upright, are taken on admission. The usual procedure of enema and Levine tube are instituted as part of the treatment of intestinal obstruction. While an attempt is being made to correct the electrolyte loss, another x-ray is taken prior to operation. If these x-rays are compared, one will note that the gas bubble is essentially in the same position and has the same configuration, the later plate revealing perhaps greater distention. If the x-rays (Figs. 1 and 2) are superimposed, one readily notes that there has not been any decrease in the size of gas bubble following attempts of decompression from above by Levine catheter and Wangenstein, and below by enema. This points to a closed loop obstruction. By recognizing the portion of intestines as that of colon by the large fluid levels and haustral markings, and by the position of the colon involved, one can make a diagnosis of closed loop obstruction involving the colon. Inasmuch as sigmoid volvulus (Fig. 3) presents an entirely different x-ray picture, one can hazard an interpretation of volvulus of the cecum. The diagnosis is made certain if a barium enema has been given on admission showing the exact location of the distal portion of the obstruction. Acute volvulus of the ileocecal segment must be considered in the differential diagnosis of all causes of acute intestinal obstruction, and vice versa. All types of acute obstruction must be thought of in differentiating volvulus.

However, as soon as the diagnosis is made, there is a definite indication for emergency operation. Signs of peritoneal irritation with intestinal obstruction are indicative of operative intervention without delay. The subsequent course of

therapy depends on the findings at operation. One may be content with simple untwisting of the volvulus with severance of any bands adherent to the loop of intestines. However, this is simply a palliative procedure and the torsion may recur at a later date. Another more feasible procedure in case the involved loop is viable, is a cecostomy and suture of the untwisted cecum and ascending colon to the posterior abdominal wall. It may be necessary to first deflate the dilated loop with a trocar and cannula before proceeding to the fixation. A few interrupted sutures will fix the ascending colon and cecum to the posterior parietal peritoneum followed by the routine cecostomy using a No. 30 Pezzer catheter. In closing the abdominal incision several interrupted sutures include the cecum above and below the cecostomy. After normal function of the bowel is re-established the opening may close spontaneously. In cases of gangrene of the cecum and adjoining ascending colon and ileum, resection must be performed as rapidly as possible. The Mayo's⁶ reported two cases in which the most conservative procedure was exteriorization of the entire volvulus. Clamps were applied to the normal bowel on either side and the involved portion was amputated by cautery. Subsequently crushing clamps were applied to the spur between the ileum and colon. When the spur was cut through, the closure of the fecal fistula was effected. If the condition of the patient is not too grave, a resection and primary anastomosis may be performed. We are presenting the latter procedure in the case to follow. Additional therapeutic aid is employed prior to the operation and in the immediate postoperative course are: infusion of 5 per cent glucose and normal saline to restore the electrolyte balance; transfusions of whole blood or plasma depending upon the findings of the hematocrit and plasma protein readings; Levine tube or Miller-Abbott tube with Wangenstein attachment to decompress any distention post-operatively. The mortality rate is definitely

related to the rapidity of surgical relief. Chalfont found reports of 119 cases and stated that of twenty-three patients not



FIG. 3. Volvulus of sigmoid.

subjected to surgery, all died. Of the remaining ninety-six who underwent some type of operative procedure, fifty-seven died, a mortality rate of 48 per cent. The total mortality was 67 per cent. Jacobson¹⁵ reported a mortality of 50 per cent in cases in which the exteriorization procedure was carried out.

CASE REPORT

N. N., age forty-one, a colored housewife, was admitted with a history of intermittent abdominal cramps of eight hours' duration. The pain was located in the umbilical region, and the patient vomited bile-stained material twice since the onset of pain. She had a normal bowel movement on the day prior to admission but had not passed flatus since that time. A gradual increase in the size of the abdomen was noted since the onset of her original symptoms. Further questioning revealed minor episodes during the past ten years associated

with habitual constipation. Hemorrhoidectomy had been performed one year before.

Physical examination revealed a middle-aged, colored female complaining of crampy abdominal pain, particularly in the left upper quadrant and the umbilical region. The abnormal findings were limited to the abdomen. Small distended loops of intestines were palpated in the umbilical and epigastric region. Borborygmi were present but visible peristalsis were not noted. Moderate tenderness was noted in the left upper quadrant. Rebound tenderness was not elicited. A stricture permitting the passage of a tip of a finger was found on rectal examination. Temperature on admission was 98°F., pulse 90, respiration 20, blood pressure 110/70, white blood cells 10,400, polymorphonuclear leucocytes 60 per cent, transitionals 10 per cent, lymphocytes 30 per cent, red blood cells 3,900,000. Roentgenograms revealed a large dilated loop of large intestines located in the left upper quadrant. Following the use of a Levine tube with Wangensteen attachment and enema which produced gas and small particles of feces, another x-ray was taken. This x-ray was essentially the same as that on the previous occasion except that the fluid levels were more distinct. Superimposition of both plates showed the same location and configuration despite a lapse of two hours under decompression measures. Operation was performed eleven hours following the onset of pain.

Upon opening the abdomen through a right rectus splitting incision, 300 cc. of foul-smelling, sanguineous fluid was aspirated. Volvulus of the terminal three feet of the ileum, cecum and ascending colon were noted. The cecum was found in the left upper quadrant. Torsion was in a clockwise fashion and amounted to 720°. No bands or adhesions were found. The mesentery attached to the cecum and ascending colon was long, and the vessels were thrombosed. The right colon was not fixed at any point to the posterior parietal peritoneum. The distended and gangrenous ileum, cecum and ascending colon were delivered, and three complete turns of the mesentery, anticlockwise were necessary to untwist the volvulus. The hepatic flexure, ascending colon, cecum and last five feet of the ileum were severed between crushing clamps. This portion of the intestinal tract was freed from its mesentery and removed from the abdomen. An end-to-side anastomosis was then performed between the ileum and

transverse colon. The abdomen was closed in layers with one cigarette drain in the cul-de-sac. The anesthesia used was 20 mg. of pontocaine, intropinally.

A smooth convalescence ensued. Initially, the patient was treated with 5 per cent glucose in normal saline augmented by Wangensteen suction syphonage. The drain was removed on the eighth day. Diarrhea developed on the ninth day but disappeared on the fourteenth postoperative day. The only complication was a small stitch abscess which appeared on the eighth day. She was discharged on the twenty-eighth day.

Three months later the patient had gained ten pounds and had no return of abdominal symptoms. Occasional bouts of diarrhea were controlled by diet and paregoric. The wound was clean, and the patient had returned to her household duties.

Comment. This case illustrates the urgency for immediate operative intervention in volvulus of the ileocecal region. With the rapid and extensive gas formation, strangulation occurs early. The roentgenograms are particularly interesting as a diagnostic aid in recognizing closed loop obstructions.

CONCLUSIONS

1. Volvulus of the cecum and ascending colon occurs infrequently. It depends upon the failure of fixation of the colon.
2. A closed loop obstruction develops with rapid progression.
3. A valuable roentgenographic aid in diagnosing closed loop obstruction has been presented.
4. The procedures of choice of operation are discussed. If the intestines are viable, untwisting, cecostomy and cecopexy is the procedure of choice. If the intestines are gangrenous, a one- or two-stage procedure with resection is indicated.

REFERENCES

1. ROTANSKY, C. Intestinal strangulation. *Arch. Gen. Med.*, 14: 202, 1837.
2. SWEET, R. H. Volvulus of the caecum, acute and chronic. *New England J. Med.*, 213: 287, 1935.

3. DU ROUX, P. Torsion du gros intestines. *Revue Gyn.*, 19: 325, 1912.
4. GATELLIER, J., MOUTIER, F. and PORCHER, P. Les volvulus du caecum. *Arch de mal de l'appar. digest.*, 21: 20-61, 1931.
5. PRATT, J. D. and FALLIS, L. S. Volvulus of the caecum and ascending colon. *J. A. M. A.*, 89: 1225-1229, 1927.
6. MILLER, J. M. Volvulus of ileocaecal region. *Proc. Staff Meet., Mayo Clin.*, 15: 424-427, 1940.
7. CHALFONT, S. S. Torsion of the caecum with review of the literature and report of a case. *Am. J. Obst. & Gynec.*, 2: 597-600, 1921.
8. TREVES, F. The Anatomy of the Intestinal Canal and Peritoneum in Man. London, 1885. H. K. Lewis & Co. Ltd.
9. SMITH, G. M. A statistical review of the variations in the anatomic positions of the caecum and the processus vermiformis in the infant. *Anect. Rec.*, 5: 549-556, 1911.
10. HARVEY, S. Congenital variations in the peritoneal relations of the ascending colon, caecum, appendix, and terminal ileum. *Ann. Surg.*, 67: 641-686, 1918.
11. WEIBLE, R. E. Volvulus. Torsion of the whole mesentery. *Surg., Gynec. & Obst.*, 19: 644, 1914.
12. WANGENSTEEN, O. H. Therapeutic consideration for the management of acute intestinal obstruction. *Arch. Surg.*, 26: 933, 1933.
13. BOROW, B. and H. Volvulus, operation and recovery. *J. A. M. A.*, 108: 43-44, 1937.
14. EASTON, E. R. and ADAMS, J. E. Incipient volvulus of caecum associated with left sided colon. *Surgery*, 1: 920-927, 1937.
15. JACOBSEN, H. *Acta Chirurg. Scand.*, 56: 181-206, 1924.



THE immediate needs for severe pneumothorax are oxygen, which at times is supplied by the longer, deeper respirations following moderate doses of morphine, or directly by oxygen with a nasal tube, and a release of the collapsed lung from the high intrapleural pressure.

The brief excerpts in this issue have been taken from "War Medicine—A Symposium" edited by Winfield Scott Pugh, M.D. New York, 1942. Philosophical Library, Inc.

SEPTIC ABDOMINAL PREGNANCY PAST TERM*

SAMUEL LUBIN, M.D.

Director, Department of Obstetrics,
Cumberland Hospital

AND

RICHARD WALTMAN, M.D.

Assistant Visiting Obstetrician,
Cumberland Hospital

BROOKLYN, NEW YORK

RECENTLY, several reports have appeared, demonstrating a difference of opinion in the details of the surgical treatment of abdominal pregnancy. Most men are agreed on the method of dealing with the placenta, preferring to leave it *in situ*, when it is attached to an abdominal viscus. Some advocate marsupialization of the sac with gauze packing, and others prefer to close the abdomen without drainage. In addition, discrepancy still exists as to when to operate in those cases in which the fetus is dead. In view of these debatable problems, and the relatively rare occurrence of a septic abdominal pregnancy past term, the following case is reported:

CASE REPORT

The patient was a thirty-three year old colored female, admitted to the Obstetrical Service of Cumberland Hospital on September 9, 1938, with a diagnosis of abdominal pregnancy. Her past history revealed an appendectomy and uterine suspension in 1931. In addition, she had a two months' spontaneous abortion several years prior to admission. She also admitted treatment by the Board of Health for syphilis. Her menses started at fifteen, recurred regularly every twenty-eight days, and lasted four to five days. Her last regular period occurred on December 20, 1937. She stained for one day each in the latter part of January and February, 1938. On March 1, 1938, the patient consulted a local physician, who told her she was pregnant. On March 2, 1938, she began to bleed profusely and passed a large clot and a mass which looked like "liver." She then bled at intervals for one week and finally stopped.

On March 9, 1938, the patient was admitted to the hospital from the Emergency Room with the complaint of cramp-like peri-umbilical pain

of two weeks' duration. The only pertinent findings at this time were those relative to the abdominal and pelvic examination. There were no abdominal masses palpable but the abdomen was moderately distended, with a tympanitic note throughout, with tenderness and rebound tenderness, which was most marked in both lower quadrants. The vaginal examination disclosed a cervix which was firm, of normal consistency, closed, directed posteriorly, and markedly tender on motion. The fundus was easily palpable in the anterior position and although it felt enlarged, the exact size could not be mapped out because of the distention and voluntary spasm of the abdominal wall. The lateral fornices presented definite induration which extended posteriorly but did not completely obliterate the cul-de-sac. The indurated area was quite tender. The impression was that of a uterine pregnancy with pelvic inflammatory disease, although extra-uterine gestation was considered. The temperature on admission was 100°F., pulse 80, and blood pressure 106/70. The white blood count was 9,600 with 78 per cent polymorphonuclear leucocytes and 22 per cent lymphocytes. The sedimentation time was twenty-nine minutes. During the next two weeks the abdominal tenderness disappeared and the temperature fell to normal. The patient promptly signed a release and then attended the prenatal clinic.

On September 9, 1938, the patient related that she had not experienced any fetal movements for the past two weeks and had lost three pounds during that interval. The abdominal examination disclosed a cystic mass arising from the pelvis about the size of a six months' gestation, and situated more to the right side of the abdomen. In addition, a hard mass was felt, arising from the pelvis to about two fingers' breadth above the symphysis and slightly to the left of the midline. In the right upper quadrant, a fetal skull was easily palpable, just beneath the abdominal wall. On vaginal examination, the cervix was found soft, closed,

* From the Department of Obstetrics, Cumberland Hospital, Brooklyn.

nontender, and continuous with the hard mass on the left side (felt abdominally) about the size of a six to eight weeks' gestation and distinctly separate from the cystic mass in the right lower quadrant.

On the evening of the day of admission, the patient's temperature was 100.8°F., and for the next few days about 101°F. On September 14th, she developed rebound tenderness throughout the entire abdomen, the temperature reaching 104°F. Her hemoglobin was 62 per cent, and the white blood count was 10,000 with 72 per cent polymorphonuclears, 18 per cent lymphocytes, 4 per cent eosinophiles, 4 per cent monocytes, and 2 per cent basophiles. The patient was given several small blood transfusions and neo-prontosil to improve her general condition and surgical intervention was withheld until the intra-abdominal infection had subsided. The expected date of confinement was September 27, 1938, and about one week prior to this date, she passed two pieces of tissue vaginally, which grossly appeared to be a cast of the uterus and histologically revealed degenerated and infected decidua.

On October 27, 1938, a laparotomy was performed under nitrous oxide-oxygen, and ether anesthesia. A midline suprapubic incision from the symphysis to the umbilicus was made, excising the old abdominal scar. The peritoneum was opened in conjunction with the anterior wall of the amniotic sac which was $\frac{1}{8}$ inch thick and contained a small macerated fetus 40 cm. in length and weighing 2 pounds, 10 ounces. The sac was adherent to the anterior abdominal wall, laterally to the sigmoid, and posteriorly to the parietal peritoneum and small intestine. The placenta was situated on the right side of the abdomen and firmly adherent to the small intestine, the right lateral pelvic wall, and in part to the anterior abdominal wall. An extra-ovular blood clot 15 by 10 by 5 cm. was found in the right iliac fossa and easily shelled out through an opening in the sac above the placenta. The fetus was removed after enlarging the incision in the sac and aspirating the brownish amniotic fluid. This fluid was nonodorous and its cultured contents were reported negative for organisms. The sac was then marsupialized after trimming its edges sufficiently to permit approximation to the anterior parietal peritoneum and wound edges by chromic interrupted sutures. The placenta was not disturbed because of its firm

attachment to the abdominal wall and small intestine. The umbilical cord was shriveled and string-like and separated from the placenta. The marsupialized sac and placenta was packed with plain gauze, and a light gauze packing was placed in the pelvis emerging from the lower angle of the wound. The uterus was found to be of about normal size, shape, and consistency, and a pedunculated fibroid 3.5 by 2.5 by 2.5 cm. coming off the fundus was removed after ligating its pedicle. The tubes and ovaries could not be identified readily and rather than invite hemorrhage by exploring, the abdominal wall was closed in layers after placing a Penrose drain in the general peritoneal cavity. A culture was taken from the peritoneal cavity and was reported after forty-eight hours as showing *Staphylococcus pyogenes aureus* and *Streptococcus nonhemolyticus*. The patient had a slight reaction with the temperature reaching 101°F. on the first and second days postoperatively and from the third day on the temperature was normal. The drains and packing were gradually shortened until final removal. The drainage, moderate in amount, continued from the sac until November 27, 1938, when a piece of tissue was discharged, and then lessened in amount, but continued even after January 5, 1939, when the patient was discharged two and one-half months postoperatively. The wound edges were almost entirely healed and there was very slight drainage for an additional week at home.

The patient, after this time, failed to return to the clinic and because of several changes in address could not be followed. However, in April, 1940, she was finally located. She had no symptoms referable to any gynecological pathology and was menstruating regularly every twenty-eight days with pain. On April 27th, abdominal examination revealed a well healed midline subumbilical scar with no evidence of ventral hernia. Vaginally, the outlet was normal. The cervix was posterior and of normal consistency. The uterus was normal in size, anterior, freely movable, and nontender, but the adnexae were not palpable. A hystrogram was done at this time and revealed bilateral tubal closure at the uterine junction.

DISCUSSION

This case of abdominal pregnancy is presented for several interesting reasons.

We observed this case when admitted early in her pregnancy, at which time she showed signs of an extra-uterine gestation which had ruptured. Since the fetus continued to grow after this episode, we have the right to assume, first, that this was a secondary abdominal pregnancy, and its location originally was near or at the fimbriated end of the tube. The clinical course, abdominal and pelvic findings led us to the diagnosis of intra-uterine pregnancy, associated with acute pelvic inflammatory disease. Extra-uterine pregnancy was not, however, ruled out.

The patient's condition was good and she was followed in our prenatal clinic. Immediately upon final diagnosis of abdominal pregnancy, the patient was hospitalized but unfortunately she began to run a temperature of between 103 and 104°F., signifying intra-abdominal infection and we preferred to wait until her infection

subsided before subjecting her to a laparotomy. About one week before her expected date of confinement, the patient had false labor and passed a decidual cast of the uterus. Incidentally, with waiting, we experienced very little hemorrhage during the operation and the placental circulation in the cord, which was atrophied and thread-like, was entirely absent. The placenta was left *in situ* because of its firm attachment to the small intestine. The sac was marsupialized and the abdomen drained because the patient had several weeks of sustained septic temperature apparently due to the infected sac contents. Two days after operative intervention, the temperature was normal, but the drainage from the sac continued for about ten weeks in all. Follow-up on the patient reveals no incisional hernia and lipiodol injection of the uterus fails to show filling of either tube with the radiopaque material.



ACUTE THYROIDITIS COMPLICATING SCARLET FEVER*

D. REES JENSEN, M.D.

Diplomat of the American Board of Surgery

NEW YORK, NEW YORK

INFLAMMATION of the thyroid gland is unusual but by no means rare. It has been reported complicating the puerperium, typhoid fever, diphtheria and other infectious processes. The rich blood supply of the gland might be a factor for its not occurring more often.

The cases reported have fallen into two groups; those which progress to suppuration, requiring incision and drainage; and those with inflammation without suppuration which usually subside with conservative measures. Since the second group are rarely operated upon there is no complete description of its pathology. Lamb¹ reported a case as follows: A colored woman, age thirty-six, two weeks after delivery entered the hospital with a temperature of 103°F. pulse 156, respiration 28; death twenty-four hours after admission. At autopsy the right lobe of the thyroid gland was apparently normal. The left lobe was very large, pale, soggy and infiltrated with fluid. The connective tissue extending down into the mediastinum was similarly infiltrated. A culture produced no bacterial growth.

DeQuervain² states: "there is hyperemia, fluidity, and disappearance of colloid. Foreign body giant cells are present with hypertrophy and desquamation of the epithelium; also leucocytic and round cell infiltration into vesicles and occasionally interstitial proliferation." After destruction of thyroid tissue fibrous atrophy may take place. Iodine content decreases which may lead to hypo- or hyper-activity of the gland.

Shields³ reports a case in a girl, age ten months, of inflammation without suppuration lasting one week, followed by

atrophy of the gland leaving the child a cretin with cessation of growth.

An enlarged gland is more susceptible to an inflammatory process. The disease indicates a bacterial origin although the offending organism cannot always be isolated. If the observer is aware that inflammation of this structure does occur, the clinical findings make the diagnosis relatively easy.

Acute lymphadenitis particularly in the region of the neck is a frequent complication of the contagious diseases, notably scarlet fever, measles and chicken pox. The superficial and deep glands or a combination of both may be involved. More often the inflammation results in abscess formation which requires incision and drainage. Infrequently the process subsides without suppuration. When the deep glands are involved the mobile structures of the neck may be displaced forward or to the right or left side often producing difficulty in breathing and swallowing. The diagnosis of deep cervical adenitis is made, but when the thyroid gland is involved, differential diagnosis becomes a problem. In this connection the following case is reported:

CASE REPORT

The patient, A. S. (No. 1883, Willard Parker Hospital), a male, age seventeen years, was admitted on March 27, 1940, with a chief complaint of hoarseness. His temperature was 102°F., pulse 108. Upon examination a punctate rash and bilateral acute catarrhal otitis media were noted, otherwise there was nothing significant. A diagnosis of scarlet fever was made.

The disease ran the usual course, the temperature becoming normal two weeks after admission. Four days later it rose to 100°F. becoming

* From Surgical Service, Willard Parker Hospital, New York City.

septic in type and at times rose to 105°F . At this time there was enlargement of the cervical lymph glands and a small mass was present in

mass in the prevertebral region at the level of the 5th to 7th cervical vertebrae which is the cause of the compression of the trachea."

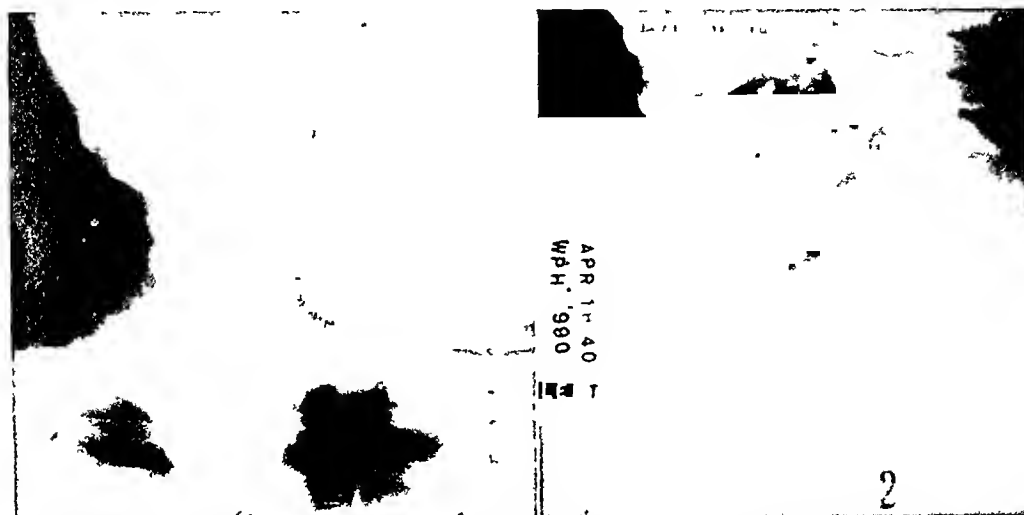


FIG. 1. A, anteroposterior view after swallowing thick barium, showing displacement of esophagus to the left. B, shows displacement of esophagus posteriorly.

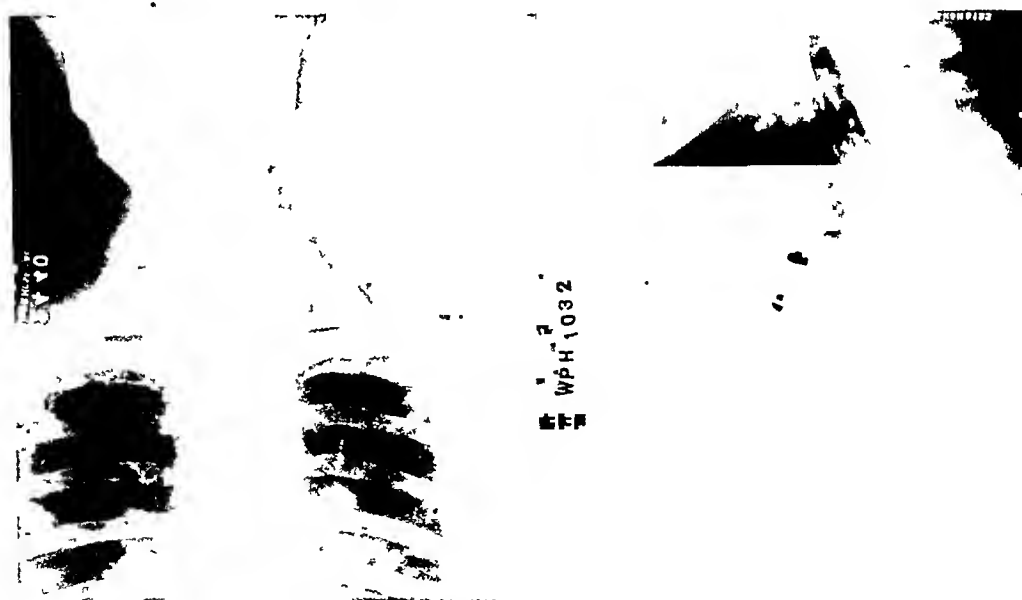


FIG. 2 X-ray taken five days later showing the normal position of esophagus, the mass in the neck having practically melted away.

the supraclavicular area to the right of the midline. Tenderness was present over this area. One observer considered this to be the thyroid gland. An x-ray taken showed "Marked compression of the trachea at the level of the 5th to 7th cervical segments. The compression is more marked from side to side than in the anteroposterior diameter. The estimated reduction in cross section is over 50%. There is a

The supraclavicular mass increased in size becoming quite prominent anteriorly, tender, firm, and the overlying skin slightly erythematous. A diagnosis of abscess of the deep cervical glands was made.

A laryngoscopic examination showed no abnormality but prompt incision and drainage was advised. After several consultations this was delayed and a second laryngoscopic

study was done. There was edema of the larynx, and a mass was described as present on the lateral aspect of the right posterior pharyngeal wall. In view of this finding prompt incision and drainage was carried out.

At operation on April 21st, a hocky-type incision was made extending upward along the mass and medially toward the midline. At this point several attempts at aspiration were made without recovery of pus. The platysma and pretracheal muscles were edematous and under tension. They were transected. As this was done the right lobe of the thyroid gland, five to six times its normal size, bulged forward. There was marked edema of the capsule and the surrounding connective tissue. The vessels were dilated and the lobe a deep red. The isthmus and left lobe were not grossly involved. Thorough palpation revealed no other masses and the cervical vertebrae were normal. Further aspiration about and through the gland was done without recovery of exudate. The capsule was stripped off and except for the lobe's attachment to the thyroid arteries, it was completely mobilized. Unfortunately, no section was taken for study. The tissues were sutured in layers and a small rubber drain left *in situ*. No drainage followed. The postoperative diagnosis was acute thyroiditis.

The white blood cells averaged 20,000; polymorphonuclears 85 per cent; the basal metabolic rate was not taken pre-operatively; four days postoperatively it was minus 4 and fourteen days postoperative, plus 5.

Upon follow-up eighteen months later two small adenomatous nodules were palpable in the right lobe, otherwise the gland was normal. The basal metabolic rate was plus 6. The patient had no complaints.

The treatment in this type of case is usually conservative. When diagnosis is uncertain, and particularly with pressure and partial to complete obstruction of the trachea or esophagus, operation is necessary, and urgent. In the above case operation apparently hastened recovery. When there is abscess of the gland prompt incision and drainage is indicated.

SUMMARY

1. A brief review of nontuberculous inflammation of the thyroid gland is presented.
2. Inflammation falls into two general groups and the treatment in each is specific.
3. A case of thyroiditis simplex complicating scarlet fever is presented and the problem of diagnosis is discussed.

REFERENCES

1. LAMB, D. S. Case of acute thyroiditis. *Washington Med. Ann.*, 6: 243, 1907-08.
2. DEQUERVAIN, KAUFMANN. *Pathology*. Translation by Reiman. Vol. 1, p. 509. Philadelphia, 1929. Blakiston & Sons.
3. SHIELDS, E. Case of acute thyroiditis in a girl of 10 months. *New York Med. J.*, October 1, 1898.



UNDESCENDED INTRA-ABDOMINAL TESTICLE WITH TORSION OF THE CORD AND EMBRYONIC CELL CARCINOMA

CASE REPORT

CLAUDE T. WHITTINGTON, M.D.

Chief of Surgical Staff, Piedmont Memorial Hospital

GREENSBORO, NORTH CAROLINA

INTRA-ABDOMINAL testicle is in itself quite rare, yet it is an established clinical entity. In a survey of the available literature, we have discovered only eleven case reports of undescended intra-abdominal testicles revealing torsion of the cord, and only five of these were associated with tumefaction and malignancy. To further complicate the above, the case to be reported revealed a transposition of viscera.

The point of origin of the testes is the genital glands. Early in fetal development the genital glands are located far front in the abdominal cavity. From this point, they migrate backward, opposite the lumbar vertebra until about the eighth week, then they proceed further caudally and normally terminate their migration at the usual location in the adult. The genital gland is attached to the mesonephros, by the mesorchium in the male. The genital cords contain the mesonephric and Muellerian ducts and develop from a ridge on the lateral surface of the mesonephros. The mesonephros atrophies leaving a band of tissue which becomes continuous with the inguinal ligament, to be known as the gubernaculum testes. Due to the fixation of the gubernaculum testis and the rapid growth in the body length, there is a tendency for the testes to be pulled downward. This descent downward is further influenced during the third month by the development of the processus vaginalis, inguinal rings and inguinal canal. The testicle being enveloped with one layer of peritoneum from its origin, it is covered by

another layer when passing from the abdominal cavity into the scrotum, the combined peritoneal coverings now being known as the tunica vaginalis propria. Two types of anomalies associated with the descent of the testicle are:

Undescended	Maldescended (Ectopie)
1. Abdominal—those retained	1. On anterior surface exterior oblique
2. Inguinal—those retained in canal	2. In Scarpas triangle
3. Pubic—those retained exterior to external ring	3. In perineum
4. Upper scrotal—those retained in upper scrotum	4. Transposed to opposite side

Torsion of the cord usually follows or is associated with stringent exercise or forceful straining, and the occurrence is usually ushered in with acute onset of pain on the respective side and occasionally with nausea. The pain and nausea usually diminishes with time, and complete cessation of pain follows onset of gangrene. Localized tenderness and rigidity in the lower quadrant is common at onset and must be differentiated from low bladder tenesmus, ureteral colic, acute appendicitis, etc.

CASE REPORT

W. R., Case No. 1145, a young male, thirty-one years of age, white, was referred to my service by Dr. Grady Siske. He was complaining of acute pain in the lower right quadrant, occurring simultaneous with a normal bowel evacuation, and becoming progressively more severe for one hour before admission. The patient was nauseated and vomited two or three times. The pain was localized definitely in the right lower quadrant and he complained

greatly on the slightest pressure over McBurney's point. There were no pathological urinary symptoms, signs or laboratory findings, and no history of similar attacks prior to this date. His temperature was 99°F., pulse 108 and respiration 22.

A long McBurney incision was made, and it revealed a transposition of the cecum to the left side and a hard mass on the floor of the pelvis, which was freely movable and attached to the edematous and twisted cord. The cord was ligated at the point of attachment and the cord and testicle resected. Further examination exposed the normal appendix (which was removed) lying along the left side of the pelvic brim and extending up to the transposed cecum.

Grossly, the encapsulated testicular mass was about the size of an egg. The outer surface was smooth with the exception of a few small nodular elevations at one pole. The cord was twisted, edematous and about 2½ cm. in width at the maximum point of swelling below the torsion.

The microscopic report of Dr. H. C. Lennon is as follows:

Microscopic section revealed a cellular tumor growth, the cells being fairly uniform in shape and size throughout. In some places it appeared as if the cells were making abortive attempts to form acini. Occasional mitotic figures were scattered about. There was no recognizable

testicular tissue in this section. There was rather extensive infiltration throughout the greater part of small round cells, along with a few areas showing actual necrosis. *Diagnosis:* Embryonal cell carcinoma in an undescended testicle.

The patient has apparently effected a complete recovery, with no evidence to date of metastasis or complications of any kind.

In conclusion, the rarity and unique pathological condition revealed in this case was most interesting and quite gratifying in that the early finding and removal of this malignant tumor, as the result of a coincidental torsion of the cord, may mean a long and happy life for this fortunate patient.

REFERENCES

1. ABESHOUSE. Torsion of spinal cord. *Urol. & Cutan. Rev.*, 40: 699, 1936.
2. KINNEY, W. H. Torsion of spinal cord. *J. Urol.*, 34: 470, 1935.
3. LAMBERT, J. and SMITH, R. E., Torsion of spinal cord. Hydatid of Morgagni. *Brit. J. Surg.*, 25: 533, 1938.
4. ORMAND, J. K. Recurrent torsion of spinal cord. *Am. J. Surg.*, 12: 479, 1931.
5. BELLER, A. J. Torsion of spinal cord and intra-abdominal testicle. *Ann. Surg.*, 102: 41, 1935.
6. VARNER, H. H. and GREEN, J. L. Torsion of cord in undescended testicle. *Am. J. Surg.*, 41: 307, 1938.



Selected Book Reviews

IN comparison with the lush days, medical publishers are not to be blamed or criticized if their lists become thinner month by month during these government controlled, war days. However, a few "more than good" works from the press are at hand for our inspection and reading. This month we have space to tell our readers about only a few of the latest outstanding works.

"Blood Substitutes and Blood Transfusion,"¹ edited by Stuart Mudd and William Thalhimer with seventy collaborating investigators (all recognized outstanding physicians) presents an up-to-the-minute description of the best current practice of this important war-time procedure. One learns of procurement, administration, storage and transportation, the newer blood substitutes and technic. With the American Red Cross all over the country getting blood from volunteer donors—a great chapter in American history—it would be well for the thousands of doctors of medicine in the armed forces to read this book carefully. Just after writing up to this point, a Commander in the medical department of the U. S. Navy dropped in on us, saw the volume, and said, "Just what I've been looking for and need." So we gave it to him. A hint to the publisher: Why not sell a raft of them to the government. The result may be that thousands of boys in this war may have their lives saved.

Then there is "Religion and Health" by Seward Hiltner² if you go in for this line.

Charles C. Thomas has brought out "The Hemorrhagic Diseases and the Physiology of Hemostasis" by Armand J. Quick.³ This timely monograph presents the fundamental factors of the coagulation of the blood, present day clinical knowledge, diagnosis, treatment and a study of this important subject.

¹ Blood Substitutes and Blood Transfusion. Edited by Stuart Mudd and William Thalhimer. Springfield, Ill., 1942. Charles C. Thomas. Price \$5.00.

² Religion and Health. By Seward Hiltner. New York, 1943. Macmillan. Price \$2.50.

³ The Hemorrhagic Diseases and the Physiology of Hemostasis. By Armand J. Quick. Springfield, Ill., 1942. Charles C. Thomas. Price \$5.00.

An interesting book, by Albert Q. Maisel,⁴ concerning the story of the new medical weapons that are and will save lives, is called "Miracles of Military Medicine." This offers a good evening's reading.

The Year Book Publishers give us the second edition of "Sulfanilamide and Related Compounds in General Practice" by Wesley W. Spink.⁵ Inasmuch as the majority of men prescribe these drugs for every ailment from falling hair to fallen arches, it might not be out of order to suggest more knowledge on this subject, hence this book.

If the anesthetists in this country were as numerous as general surgeons, we would make a major issue of John S. Lundy's "Clinical Anesthesia," with 266 illustrations.⁶ Again, the government might invest in a few hundred (or should we say thousand) copies and distribute them among the lads who "sling" anesthetics in the army, navy, marines, coast guard, flying forces, et al. This is an excellent and important book.

Macmillan offers us Maurice Levine's "Psychotherapy in Medical Practice," a non-technical handbook⁷ intended for the general practitioner and medical student. This book is interesting and instructive.

"Human Embryology" (one of the Medical Student Series) by Joseph Krafka, Jr.,⁸ was written to meet the demand for a short, concise, complete textbook of embryology. If you are interested, we recommend it.

Medical students, advanced Red Cross workers, and many others who have taken the usual first aid courses are recommended to follow it up with Cole and Puestow's "First Aid . . . An Advanced Guide." We mention this excellent book⁹ so that physicians will know

⁴ Miracles of Military Medicine. By Albert Q. Maisel. New York, Duell, Sloan and Pearce.

⁵ Sulfanilamide and Related Compounds in General Practice. By Wesley W. Spink. 2nd ed. Chicago, Year Book Publishers. Price \$3.00.

⁶ Clinical Anesthesia—A Manual of Clinical Anesthesiology. By John S. Lundy. Philadelphia, 1942. W. B. Saunders. Price \$9.00.

⁷ Psychotherapy in Medical Practice. By Maurice Levine. New York, Macmillan.

⁸ Human Embryology. By Joseph Krafka, Jr. New York, 1942. Paul B. Hoeber, Inc. Price \$4.75.

⁹ First Aid—Surgical and Medical. By Warren H. Cole and Charles B. Puestow. New York, 1942. D. Appleton-Century.

what to recommend when a patient asks, "Doctor, what is the best advanced first aid book? I've finished the beginner's course in first aid and I want to go on from there."

The Oxford University Press¹⁰ gives us the Oxford Medical Outline Series . . . Public Health and Preventive Medicine . . . Gastro-Intestinal Diseases . . . Urology . . . Gynecologic Surgery. They are just what they claim to be—outlines of the subject. If you are a recognized specialist, you will not be interested; all others will find them valuable reading.

And we have the fourth edition of "Fractures" by Paul B. Magnuson.¹¹ It is well illustrated and has won its proper place by being among the best. Again, this is a book the government might with profit distribute among the army and navy medical personnel.

Probably most men in the medical corps of our armed forces, especially those en route to the tropics, are familiar with "Medical Parasitology" by James T. Culbertson.¹² Malaria and sleeping sickness (to mention only two common discases) infect a large part of the world's population. Now, they threaten many Americans in the armed forces. This volume describes the parasitic animals which have medical importance and points out the various manners by which they establish themselves upon human beings. We learn etiology and the accepted methods of diagnosis, together with procedures which have proved effective for eliminating the parasites from persons already infected. This book fills a great need and we recommend it most highly.

¹⁰ Oxford Medical Outline Series. Published by Oxford University Press, New York.

¹¹ Fractures. By Paul B. Magnuson. Philadelphia, 1942. Lippincott. Price \$5.50.

¹² Medical Parasitology. By James T. Culbertson. New York, 1942. Columbia University Press. Price \$4.25.

The American Journal of Surgery

Copyright, 1943 by The American Journal of Surgery, Inc.

A PRACTICAL JOURNAL BUILT ON MERIT
Fifty-second Year of Continuous Publication

NEW SERIES VOL. LX

JUNE, 1943

NUMBER THREE

Editorials

THE USE OF COLOR IN THE OPERATING ROOM*

IN September, 1941, a change was made from white to green in the linen of our operating rooms. The change was premised (1) on the knowledge that eye strain is caused by the glare of the white linen and walls of an operating room, (2) on the knowledge of the satisfactory use of color in other operating rooms, and (3) on the desire to obtain harmony in the general color scheme, as in the construction of the operating rooms of the hospital the wainscoting, ceilings and floors had been finished in green. The change had been contemplated but was deferred for a considerable time due to our lack of knowledge of the actual procedure and with the belief that it would be rather complicated and difficult. Much to our surprise the change was easily made and found to be simple and economical, not requiring the purchase of additional equipment.

Although the use of colored linen is not new, especially in some localities, we have had many inquiries in regard to the actual dyeing procedure from visiting surgeons, physicians, hospital administrators and many others. An advantage not anticipated has been the ease of handling the linen of the operating room, the green color making it less likely to be mixed with contaminated white linen from other parts of the hospital.

It is, therefore, believed that a brief

review of the subject together with our method of procedure for dyeing the linen may be of interest to others engaged in hospital work.

On the whole, the literature on the subject is scanty. It seems, however, that in this country Sherman,¹ about thirty-six years ago, in operating upon cleft palates in little children, began to use black cloth around the mouth in place of the ordinary white toweling with the result that the back of the patient's mouth came into the high light, which greatly facilitated the surgery in the back of the oral cavity.

Flagg,² in his very excellent paper, discusses the scientific basis for the use of color in the operating room. He points out that in any practical scheme of decorating and furnishing operating rooms there should be included the matter of obtaining maximum amount of ease and comfort to the eyes of the surgeon and other operating room personnel. In this connection, Paul³ relates the interesting accomplishments and potentialities of color as a medium of aid in the healing of the sick.

According to Flagg,² it is obvious that white, the ancient symbol of purity indicating a freedom from moral and physical contamination, was the choice for use in the operating room. The profession and public have regarded not only the "men in white" but the operating room and hospi-

* From the Surgical Service of the U. S. Marine Hospital, Boston, Mass.

tal decorated in white as the criterion of cleanliness and asepsis.

Flagg² and others agree that the traditional white walls, white enameled equipment, pure white draperies and toweling used in the operating room neither conserve eyesight nor produce the greatest efficiency on the part of the operating room personnel. Particularly is this true now as surgical intervention has become quite complex and operations within closed cavities are more frequent and are done under stronger lights for the operative field. It is also pointed out that the greater light reflection seriously affects the operator's view of the field of operation, producing greater degree of eye strain and color fatigue.

Eastman⁴ states that no matter how strong or perfect one's vision may be, strong artificial light as well as sharp sunlight reflected from glistening white surfaces must harass the eyes. The color fatigue associated with the use of white linen has also been considered as identical with snow blindness. This, of course, is due to the greater degree of pupillary reaction and retinal adaptation which take place when one looks up from the wound to the white draperies and walls and then back into the less illuminated wound.

Since the white operating room is scientifically and physiologically incorrect, it was but natural to have suggestions regarding necessary changes from the white. These suggestions came from various groups of persons, including surgeons, medical men, architects, interior decorators, and stage lighting experts. These persons, according to Flagg,² included (1) those interested in the ensemble of the operating room (views aesthetic and psychological) and (2) those interested in the operating room as a laboratory with an interest focused upon the field of operation (views utilitarian or physiological). Also it was logical, since the operating room was merely a setting for the patient and field of operation, that the physiological point of view predominated.

It is further pointed out that the chief

difficulties presented by the field of operation are (1) illumination, (2) reflection, and (3) color fatigue. Operations, however, are rarely performed by the exclusive use of daylight. Adequate lighting in the operating room usually is furnished by artificial lights with yellow rays so the problem of supplying daylight is unessential. The problem of reflection is easily solved by using any number of colors in the operating room. Color fatigue, on the other hand, can be satisfactorily prevented only by employing a true complementary color to the operating field. Flagg² states that the true complementary color to the operating field has been shown scientifically to be a bluish green which permits maximum illumination. Sherman¹ had previously recommended spinach leaf green as the complementary color to red, blood and tissues.

The successful use of complementary colors is not generally understood. A complementary color always intensifies its opposite, as is demonstrated by the use of the port (red) and starboard (green) lights and the "stop" and "go" traffic signals. Green is by no means the only color used in operating rooms. In many instances blue, red, French gray, ivory, and even combinations of colors, have been used. In the selection of the various colors for the operating room, however, there has not always been scientific consideration of the color of the field or operation or whether the color was complementary in nature.

From a scientific as well as a practical standpoint, therefore, a blue-green or spinach-leaf green is the color of choice for use in the operating room. It should include all draperies, caps, masks and gowns, and, where possible, the furniture, wainscoting, ceilings and floors.

In making the change from white to green, the actual dyeing of the white linen was done in the station laundry. The dye used was "Erie Green G. Y.," which was procured at a cost of sixty-three cents a pound.

The actual procedure of dyeing is as follows: Fifty pounds of white, clean, dry

linen is placed in the washing machine and thoroughly soaked in sufficient boiling water to float the material. Two and one-half ounces (three tablespoonsful) of dye are dissolved in two gallons of boiling water, which is slowly added to the water and material in the machine, which is running at slow speed. This is allowed to run for about five minutes, after which four pounds of common table salt are added. The linen is then brought to a boil and the boiling is continued for thirty minutes. The linen is then taken out and rinsed two or three times to remove the excess dye, after which it is dried or mangled in the usual manner.

After ten to twelve launderings subsequent dyeings in weaker solutions may be

necessary in order to maintain the particular shade of color.

REFERENCES

1. SHERMAN, HARRY M. The green operating room at St. Luke's Hospital. *California State J. Med.*, 12: 181-183, 1914.
2. FLAGG, PALUEL J. A scientific basis for the use of color in the operating room. *Mod. Hosp.*, 22: 555-559, 1924.
3. PAUL, M. RAL. How color affects the mental attitude and physical condition of patients. *Mod. Hosp.*, 22: 260-265, 1924.
4. EASTMAN, J. R. Tinted operating rooms. *J. Indiana M. A.*, 7: 366, 1914.
5. CUTTINGS, JAMES A. The reaction of the pupil to colored light. *J. Nerv. & Ment. Dis.*, 46: 246-250, 1917.
6. LUDLOW, WILLIAM O. Color in the modern hospital. *Mod. Hosp.*, 16: 511-513, 1921.

RICHEY L. WAUGH, M.D. AND
ESTHER M. WELCH, R.N.

A NEGLECTED POINT IN BURN THERAPY

NEARLY every surgeon and certainly every medical officer is "burn conscious." The tremendous interest in burns which preceded our entry into the war has been accelerated since and has centered to a large extent on the problem of plasma loss and plasma replacement and to a lesser extent on water balance.

One very important way of meeting these problems has been badly neglected or if not neglected certainly not stressed enough. It is simply the giving of water and liquid food by mouth—the most natural, the easiest, the physiologic way—the way which in the long run must be depended upon anyhow if the patient is to get well.

The whole crux of the situation is whether or not the burned individual can retain things given orally and retaining them whether he can utilize them.

Vomiting has not been an outstanding symptom in the cases of burns I have seen nor is it listed as common in articles covering large numbers of cases. Granted that in some instances vomiting is marked, by the end of twenty-four to forty-eight hours it has usually ceased and the oral route is available while the case is still an early one and probably not yet out of "burn shock."

It may be argued that due to mucous membrane edema or for other causes, metabolism may be so interfered with that the body cannot utilize fluid or food which has reached the gastrointestinal tract. Is not this an assumption rather than a proved fact? But if it is true in the freshly burned patient, it is only temporarily so. The body should have a supply of the needed raw materials on hand for that very first moment when it does regain its ability to metabolize material from the gastrointestinal tract which while somewhat reduced at first is never entirely lost. At least this ability has not been given a fair chance to demonstrate itself.

As far as water balance goes, if we have a patient who can drink and retain water it is common sense to give him enough and let his regulatory mechanisms guide the taking up of what is needed, when it is needed and when the body is able to take it up. Sodium chloride and glucose may be added to the water if desired. We are often so busy giving patients intravenous solutions, carefully balanced against the plasma replacement dosage, that we fail to provide them with a drink of water. At all events the getting of fluid into the burned patient's

stomach is not pushed with the same meticulous planning and persistent execution as is intravenous therapy.

Plasma infusion is ideal and life saving in the emergency in which it is obvious that the body is not able adequately to call on its own protein reserves. But how long are the foods from which the body could replace and supplement its own lost and fixed protein and plasma withheld and emergency measures depended upon entirely? If, as has been shown by clinical observation plasma, even that added by vein, continues to leak into the body tissue or out of the burned surface for forty or more hours, why not supplement the temporary administration of plasma by a liquid diet

high in protein, of measured amounts and administered at planned intervals? In an unconscious patient a tube could be used. "Casec" milk shakes such as are used by Ravdin in his preoperative preparation of patients with liver damage would be one convenient way, amino acids as used by Robert Elman another. Vitamins, especially vitamin c, are indicated, first by injection, but as soon as possible included in the oral liquids.

This discussion is in no way directed against the use of plasma or saline and glucose intravenously in the treatment of burns. It is directed against the complete reliance upon them to the neglect of a simple, ready and effective means of therapy.

MAJOR EDWARD F. McLAUGHLIN, M.C.



FOR THOSE IN SERVICE

AN interesting non-commercial contribution in behalf of medical officers in the services of our Armed Forces is the pocket size publication called *Medical Journal Abstracts*. Prepared by the library staff of E. R. Squibb & Sons, it is distributed gratis to each station, camp, hospital or post in sufficient quantity to supply every physician located therein with a copy. A thin, bible paper edition is prepared for distribution overseas.

Medical officers wherever located will find this publication of much value in keeping abreast of advances in clinical medicine.

Original Articles

SURGICAL OPERATIONS WITH THE NAVY MEDICAL CORPS IN THE SOUTH PACIFIC*

LIEUT. COMDR. W. M. JOHNSTON, M.C.-V(S) U.S.N.R.

SEATTLE, WASHINGTON

OUTSIDE of routine surgical care that any large group of young men require, warfare brings the surgical treatment of our armed forces under two main headings: (1) the treatment of burns, and (2) the treatment of combat wounds.

What may not be known by the average layman, is that the U. S. Marine Corps is under the Medical supervision of the U. S. Navy. Therefore, all Marine casualties are the responsibility of the Navy Medical Corps as well as the casualties of the Navy Department itself.

As a Navy Medical Officer, I had the fortunate, or unfortunate, experience to be attached to duty in the South Pacific in the summer and autumn of 1942 and was present in our first offensive against the enemy in that region, or in fact, our first offensive in this war in any region. It so happened that I was fairly severely wounded in action against that enemy. Before that circumstance, I had an opportunity to care for and observe some of our casualties, and afterward to be under care myself in our own base hospital and eventually as a patient in the same Naval Hospital in the United States, where I had previously been on duty before going to sea. Under the care of this same Medical Corps of which I am proud to be a member, I made an excellent recovery and returned to active duty in February, 1943.

It is a rare opportunity and education as

a surgeon to have the privilege of attending battle casualties for a time and then to be under care personally as one of these casualties by your fellow officers. You observe and experience all these things from both points of view and it is far more enlightening than reading a dozen volumes about it.

My report will be from the rather broad experience of action on land, action at sea, including a night alone in a life jacket while wounded, as a member of the surgical staff and a patient in an advanced Naval Base Hospital, as a patient on a hospital ship, and finally as a patient and member of the staff of several Naval Hospitals in the United States.

Reserve Medical Officers in our first year of foreign duty were almost exclusively the group of specialists who had been members of the Medical Specialists Units which had been organized by the Navy throughout the United States for several years. Due to the ability of these highly trained men and their modern and efficient methods, to the use of the sulfa drugs, to the abolition of worn-out methods, to the fact of prompt attention and careful follow-up, both the mortality and morbidity of the battle casualties have been kept far below that of any other war of all history and below that which we ever dreamed possible. The American people can be sure that their sons will have the best medical and surgical care that is known in the world today.

*The opinions and views set forth in this article are those of the author, and are not necessarily to be considered as reflecting the policies of the Navy Department.



Corner Drug Store—Gundalcanal (U. S. M. C.)

Most of the wounds occurred in young, healthy males and the advantage of that kind of material is well known to any Medical Officer of any experience. In our opinion, one of the mistakes of the Navy Department after Pearl Harbor, was lowering the restrictions and physical requirements for enlistment. This was not done at the request of the Medical Department as any Medical Officer of experience knew that would be a mistake. The Medical Department has been busy surveying these men out of the service ever since and will continue to do so, at considerable expense to the taxpayers: Unfortunately, one-half of the casualties which returned to the States on the transport with me were not battle casualties, but men who in the language of the service, could not "take it." From my observations, I must say that I do not think the physical requirements or mental qualities of candidates for the Navy should be lowered in any manner. There is no advantage of any kind to be gained thereby, and there are countless disadvantages. We have to remember the drastic action rule of warfare, namely, that a dead man gives much less trouble than an incapacitated one.

1. THE TREATMENT OF BURNS

The subject of burn treatment is of considerable importance in naval warfare, especially in casualties aboard ship. It happened that we had an opportunity to observe many of the casualties from the aeroplane carrier Wasp after she had been sunk by a submarine. It happened that most of the casualties aboard her were burns, resulting from explosion of gasoline on her decks.

There have been numerous publications in the surgical journals in the last few years on the treatment of burns—most of these authors stressing external applications of first one product and then the other. Often in combat in various surroundings you may not have the opportunity to use what is desirable but what you have. In my opinion, in case of severe burns, it is not so

much what you use externally that counts but perhaps what you use internally. Your job as a physician is to keep the patient alive, especially during the first twenty-four hours. Again our anchor sheet is plasma. Do not be afraid to use too much, but be certain that you use enough.

I will briefly outline the treatment of burns that we suggest in the Navy, but bear in mind that all these ideal treatments may not be available for several hours under actual combat conditions.

When the burn first happens, the first aid treatment should keep the four cardinal principles in mind: (1) To keep the burned area from further contamination; treat it as an open wound; (2) to prevent and combat shock at once, by plasma transfusion as soon as possible; (3) to control pain, which also combats shock; and (4) to minimize fluid loss.

You should then administer 4 gr. of sulfadiazine by mouth which should be in the first aid pouch. Get the morphine to the patients promptly. If the burn is extensive, give them $\frac{1}{2}$ gr. of morphine. Administer the "booster" dose of $\frac{1}{2}$ cc. of tetanus toxoid.

Remove rings from fingers; apply boric acid ointment over the burned surface, if available, otherwise use vaseline. Lay two layers of fine mesh gauze over the ointment, place the first aid dressing gauze over this, then apply a muslin bandage snugly over all. Finally, if an extremity is burned, splint it. When the patient reaches the Base Hospital, the real treatment starts.

To overcome shock, prompt administration of plasma is commenced. Quantities up to 12 units may be required in the first twenty-four hours in severe cases. When the patient is in critical condition, the first plasma should be given rapidly, the first 500 cc. in five minutes.

For treating the burn itself, the Medical Officer and all his assistants should be masked, and the burned area treated as an open wound. The first aid dressings are removed and the burned area cleansed. If covered with oil, it is removed by a deter-

gent, supplied by Naval Medical Supply Depot; in an emergency, sterile lard or mineral oil may be used. Afterward, the area and the surrounding skin are cleansed carefully with white soap, brushes are not used, yet the area is carefully cleansed with the soap.

Gowns are then changed and careful débridement carried out. All blisters and loose shreds of skin or tissue are removed with sterile instruments. Deeper tissue that may appear to be damaged should not be débrided at once, as it may be done secondarily in a few days if necessary. Remember at all times to treat the burn with the same respect as you would an open wound.

After cleansing and débriding the area, it is dressed by applying a fine mesh sterile gauze impregnated with boric acid ointment or vaseline. A smooth thick layer of sterile gauze is applied over this and these dressings are held in place by a smooth, evenly applied bandage. Firm pressure is important as it prevents serum loss. Finally, if an extremity is involved, a splint is applied. Unless complications develop this dressing is not disturbed for about ten days; then you will find that all first and second degree burns will be largely healed. Areas of whole skin thickness loss, that is, third degree burns, should be prepared for grafting by excision of all dead tissue and further preparation if suppuration is present, but skin grafting should be done at the earliest possible moment when there is a full thickness skin loss.

During this time, do not forget the four cardinal principles: (1) control of pain (2) replacement of fluid loss, by plasma at first, later with glucose and whole blood as anemia develops (3) the prevention and combatting of shock as promptly as possible, and (4) the treatment of all burns as open wounds.

II. COMBAT WOUNDS

As we stated, outside of routine surgical conditions and burns, all surgical care during warfare is either due to or the com-

plications of wounds of various types received in combat. In discussion of these wounds I do not desire to take them up section by section, but merely to state a few observations made from treating these cases and from the personal experience of receiving a few of these wounds myself. This latter you possibly will not read about in text books.

Two forces are at play if a missile is lodged in the organism, namely, the energy of the missile and secondly the resistance of the body. The energy of a missile equals half its mass times the square of its velocity. Thus we see that the velocity is of much greater importance than the mass. For example, the initial velocity of hand grenade splinters may be as high as 2,000 meters per second and splinters weighing only 1 Gm. have force enough at this speed to fracture a femur. The less the velocity, the more likely that a missile will remain in the body. Air resistance and gravitation, especially if a missile is directed upward as in mountainous territory or in airplanes has its effects, as the velocity is reduced. According to this mathematical calculation, the greater the mass of a missile, the greater is its penetrating power provided the velocity remains the same. For this reason someone has said large missiles are less likely to remain in the body than small ones. True, but unfortunately the human body is a poor resistance against the missile of modern warfare. I have seen eight-inch shells go through a destroyer like through a parchment box. I have seen them cut off coconut trees like toothpicks. I saw three bombs from planes four miles high, hit a destroyer simultaneously and sink it in exactly two minutes. Naturally, when this type of missile hits a human body there just is no body. So that the wounded we treat are the survivors or the ones who were struck by comparatively small missiles, shrapnel and other fragments and rifle bullets. Hence they take various and divers courses when they strike the human body, both due to their direction and velocity and to the resistance of that part

of the human body they strike, such as bone.

Also the part of the body these strike makes a great deal of difference in the pain and reaction of the man in combat. I remember that I received several shrapnel wounds that were flesh wounds and although they made quite large openings, I did not feel any of them when they were made. Yet, when hit in the water over the lumbar area with a large piece of spent shell which did not break the skin, it seemed as though someone had broken my back.

I remember treating a marine who had been struck in the head of the right humerus by a rifle bullet which knocked him down and turned him completely over. He said he thought someone had hit him in the shoulder with a baseball bat.

At the Base Hospital, missile or foreign bodies are removed if they are immediately accessible, if they are the cause of an infection, if they intrude upon or endanger any important structure as a nerve or large blood vessel, or if they are in a joint. Otherwise they are not disturbed. In locating these foreign bodies, x-rays taken in the anteroposterior position are a great aid and at times operating directly under the fluroscope may be necessary and also may save much time and blind searching.

Wounds received in action showed an interesting contrast in regard to infection between those patients who were in the water after they had been wounded and those who were on the land. Those that were in the salt water for several hours had much less infection and healed cleaner than those secured on land.

Personally, I had nine separate wounds and spent eight hours in a life jacket in the salt water at Guadalcanal, which is very warm in this tropical area. We did not have a sign of infection in any wound and I saw this happen in dozens of cases and in wounds much more severe than mine. This fact gives us the idea which we carried out, that there is nothing of more value to clean a combat wound than warm saline.

Wounds, except for wounds of the abdomen and perhaps wounds of the face and lips, are better treated without suturing. The best suture material is alloy-steel wire, using the very fine sutures on the face. Even in the case of abdominal wounds with colon perforations we do not believe that the skin and subcutaneous areas should be sutured.

We believe that with the correct and prompt use of the sulfonamides, débridement which was advised so strongly in the latter part of World War I and is still advised in many of our recent publications, can largely be dispensed with, except in definitely destroyed tissue. Otherwise its use, we believe, is destructive and harmful.

Many of the wounds that are treated conservatively can have a secondary closure later, while a case of radial débridement often will require many weeks of plastic surgery and skin grafts, to say nothing of the possible injury to important blood vessels and nerves.

In case the wound caused a compound fracture of the extremity, good results were obtained by treating the wound with sulfathiazole or sulfanilamide, leaving the wound open. Those that were closed became infected and had to be opened later, and immobilized then in plaster for safe transportation. The only disadvantage in this type of treatment was the lack of traction in cases in which it was indicated. But when these cases reached the Base Hospital, they responded well to traction by the Stader splint or other methods of the Orthopedic Medical Officers and the end results as a whole were excellent.

At the first dressing on the battle front as in sea battle, the wounds are simply cleaned with warm saline solution and on the outside with white soap and then are sprayed with sulfathiazole; or the wound has one of the sulfa drugs in the powdered form introduced directly into the wound and a snug dressing applied before his transfer to a Base Hospital or a hospital ship. Naturally, hemorrhage is checked,

and morphine is still the great dependable drug in combat wounds.

In case of shock in the wounded, we do not forget the life saving plasma intravenously or blood transfusion when hemorrhage is present as it often is in these wounds. In severe wounds the old treatment of morphine, heat and fluid, has been changed to morphine, sulfonamides, plasma and whole blood. The "booster dose" of tetanus antitoxin is administered, as is also the prophylactic dose of gas bacillus antitoxin if the Medical Officer thinks it is indicated.

A word about gas bacillus infection and gas gangrene. We find with our modern methods of treatment the evidence of gas bacillus infection is markedly lowered when compared with that of World War I. When it does occur, we find that the conservative treatment of exposing the infected muscles, the use of sterile zinc peroxide, and the use of gas gangrene antiserum will largely replace the old method of radial amputation in these cases.

Immobilization that proved to be of such benefit in the latter part of World War I, is still carried out in all severe wounds of the extremity. It prepares the patient for transportation and saves many lives.

During the offensive last summer, the severely wounded, after these other treatments, were placed in casts or splints and taken by areoplane to the next available hospital with a very low mortality. And in our opinion, the areoplane will be the ambulance of the future and in the present war in the Pacific. It can easily transport the severely wounded for hundreds of miles in a few hours to a comparatively safe hospital, and deliver the patient with a minimum of added trauma. When these wounded are landed at the Base Hospital, they are treated as the individual case indicates. The officers and corpsmen are schooled in all the complications, especially that of secondary hemorrhage and should always be on the lookout for it and ready to handle it promptly.

Lastly, I repeat, in whatever part of the combat you are called upon to serve, do not forget our great aids in case of combat wounds, namely, morphine, sulfonamides, plasma and immobilization. If the question of radial or conservative measures should arise in treating any combat injury, except wounds of the abdomen, use the latter and I am sure your results will continue to be brilliant and gratifying.



INTRA-ABDOMINAL INJURIES*

COSTABILE DI LORENZO, M.D.,
Assistant Surgeon, Harlem Hospital

MILTON ROTHMAN, M.D.
Research Fellow in Surgery, Harlem Hospital

AND

CLARENCE HOWLEY, M.D.
Director of Surgery, Harlem Hospital
NEW YORK, NEW YORK

THIS communication is concerned with the study of 115 patients with intra-abdominal injury treated at Harlem Hospital from January 1, 1938, to December 31, 1941. All cases of stab wound, gunshot wound and nonpenetrating injury of the abdomen, with injury to intra-abdominal viscera or vascular structures, treated during the period of this report, are included in this study. Those cases of penetrating wounds of the abdomen without injury to intra-abdominal structures, as well as those cases of nonpenetrating injuries that were not explored, are excluded from this report.

This study of 115 cases includes seventy-nine with penetrating stab wounds of the abdomen, sixteen with gunshot wounds and twenty-nine with nonpenetrating intra-abdominal injuries. Of the 79 patients with stab wounds treated, sixty-six were males and thirteen females, a proportion of 5 to 1. All were colored, a fact which is not surprising since 90 per cent of the patients at Harlem Hospital are colored. The wounds were inflicted by ice picks in two cases, scissors in one case, and by a fall over a glass top table in another case. In the remaining cases the injuries were produced by knives, often of the switch blade variety. The gunshot wounds were most frequently inflicted by pistols of .32 or .38 caliber. Accurate details of the distance between the firearm and the patient, as well as the relative positions of the victim and the assailant, and consequently of the direction of the bullet, were not available owing to the confusion existing at the time of in-

jury. The nonpenetrating injuries were caused by automobiles in ten cases; in four they resulted from falls, in three from blows or kicks, in two they were produced from sleigh ride injuries, and in one case the cause could not be determined.

In all the cases with penetrating stab wounds of the abdomen, no patient had more than one penetration into the peritoneal cavity. Figure 1 reveals the location of these wounds. A large preponderance in the number of wounds will be noted in the upper third and left half of the abdomen. This is probably due to the fact that the blows were struck by right handed assailants in the majority of instances, and would naturally fall on the left side of the victim's body.

In the gunshot injuries, there were sixteen wounds of entry and ten wounds of exit. In all cases there was only one wound of entry. Figure 2 shows the approximate paths of the bullets obtained by connecting the wound of entry with the wound of exit. Where no wound of exit was present, the path of the bullet was obtained by studying the position of the bullet as noted at operation or on roentgenograms, in relation to the wound of entry.

In the nonpenetrating injuries, the injured viscera were either the solid organs or hollow viscera close to their points of fixation.

The average period that elapsed from the time of injury to the time of admission to the hospital was seventy minutes for the entire group. The time was essentially the same for the group that died and the group

* From the Surgical Department at Harlem Hospital.

that survived. The period between the time of admission and the time of operation was 180 minutes. This interval was necessarily

The most frequent finding in penetrating stab wounds of the abdomen is injury to the liver. This was found in twenty-nine, or 36

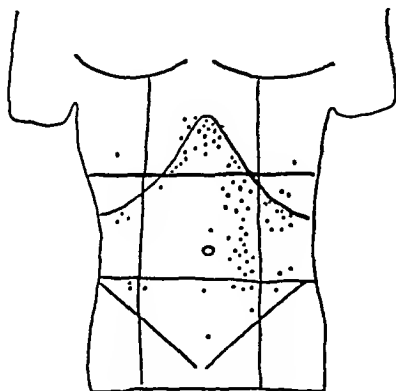


FIG. 1. Location of stab wounds.

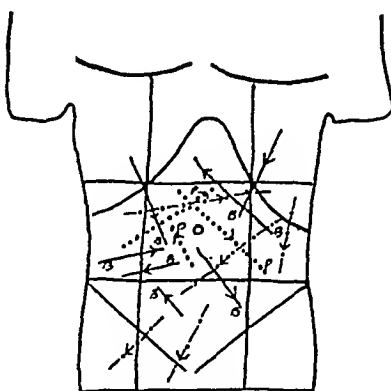


FIG. 2. Approximate path of bullets.

P . . . signifies the bullets that exited posteriorly; B shows the location of bullets found in the abdomen.

variable depending in many instances on the period required for the observation of the patient, for the preparation of the patient for operation and for the treatment of shock. These figures do not include four cases in which patients refused operation for twelve to eighteen hours. The average time elapsing before operation for the group that survived was 160 minutes and for the group that died was 190 minutes. Practically all patients were brought to the hospital by ambulance; a few were brought in by taxicabs.

TABLE I
PATHOLOGY OF STAB WOUNDS

Organ	Combined Injuries		Pure Injuries	
	No.	Per Cent	No.	Per Cent
Liver.....	29	36	22	27
Eviscerations.....	23	28		
Vascular injuries.....	19	24	1	
Stomach.....	15	18	8	10
Small intestine.....	15	18	5	6
Large intestine.....	12	15	7	11
Gallbladder.....	3	..	1	
Kidney.....	1			
Bladder.....	1	..	1	
Pancreas.....	1			
Pneumothorax.....	9	11		
Associated spillage.....	53	67		

per cent of the stab wounds. (Table I.) In twenty-two of these the laceration of the liver was the only intra-abdominal injury present.

Eviscerations occurred in 28 per cent of the cases. Next in frequency were the vascular injuries which include injuries to the greater and lesser omentum, major blood vessels and retroperitoneal hematoma. Injuries to the stomach, small intestine, and large intestine followed in the order named. Intraperitoneal spillage of blood, gastrointestinal content, bile or urine occurred in fifty-three or 67 per cent of the cases. There was an associated pneumothorax in eleven cases, these cases representing combined intrathoracic and intra-abdominal injury.

In gunshot wounds of the abdomen the most frequent injury found was to the small intestine. (Table II.) Injuries to the large intestine, vascular structures, liver and stomach followed in the order named. Multiple injuries were present in thirteen out of fifteen cases. In one case the injuries could not be ascertained as the patient died before he could be operated upon. Pneumothorax was found in three cases, denoting combined intrathoracic and intra-abdominal injury. An intraperitoneal spillage of

blood occurred in nine or 60 per cent of the cases.

TABLE II
GUNSHOT INJURIES

Organ	No.	Per Cent
Small intestine.....	9	56
Large intestine.....	7	43
Vascular injuries.....	7	43
Liver.....	3	19
Stomach.....	2	12
Spleen.....	1	
Kidney.....	1	
Bladder.....	1	
Eviscerated omentum.....	1	19
Pneumothorax.....	3	
Spillage of blood.....	9	60

In twenty cases of nonpenetrating intra-abdominal injury, the spleen was involved in nine, the small intestine in six, the liver in four, and the urinary bladder in one. A gross intraperitoneal spillage of blood was present in thirteen or 65 per cent of the cases. In one case there was a complicating pneumothorax.

Intra-abdominal injury results in injury to the hollow viscera, solid organs and vascular structures. This in turn may result in the intraperitoneal spillage of blood, gastrointestinal contents, bile or urine. This spillage into the peritoneal cavity may give rise to the signs and symptoms encountered in intra-abdominal injury. However, perforation of the gastrointestinal tract without gross spillage may also be associated with signs and symptoms pointing to the abdomen. Vomiting, abdominal pain, tenderness, rigidity, rebound tenderness, distention, and traumatic evisceration may be present with or without the symptoms and signs of an associated shock. In passing it may be mentioned that evisceration at the time of injury is a pathognomonic sign of a penetrating injury of the abdomen. The local signs of intra-abdominal injury may be masked when the patient is in shock or under the influence of alcohol.

Whenever gross intraperitoneal spill was

present, abdominal signs and symptoms were almost invariably present. In only four of the cases with stab wounds of the abdomen out of the fifty-three cases with intraperitoneal spillage were abdominal signs and symptoms lacking. (Table III.) Two of these patients were in shock on admission. Of the remaining two patients

TABLE III
RELATION OF SYMPTOMS AND SIGNS TO GROSS INTRA-PERITONEAL SPILL

Pathology	Total	Symptoms	Eviscerations	Asymptomatic	Asymptomatic with shock
Blood spillage....	46	37	7	2	1
Gastric spillage..	6	5	0	1	1
Bile spillage.....	1	0	0	1	0

without signs or symptoms, one had laceration of the liver, and the other a wound of the gallbladder.

There were forty-four patients with perforation of the gastrointestinal tract due to stab wounds. Fifteen had perforations of the stomach, fifteen of the small intestine, and fourteen of the large intestine. (Table

TABLE IV

Perforations	Total	Symptoms	Eviscerations	Asymptomatic	Asymptomatic with Shock
Stomach.....	15	14	0	1	1
Small intestine...	15	13	2	0	0
Large intestine...	14	9	2	3	1

iv.) All had symptoms and signs pointing to the abdomen except one case with a perforation of the stomach, and three cases with perforations of the colon. Two of these patients, one with a perforation of the stomach, and one with a perforation of the colon entered the hospital in shock. In summary, of the seventy-nine patients

with stab wounds treated, all had either gross intra-abdominal spillage, or perforation of the gastrointestinal tract. Only eight of these patients had no symptoms or signs pointing to the abdomen, and four of these were in shock on admission.

are to be considered of value only if positive. Roentgenograms are of value in locating bullets, and also in evaluating associated injuries of the chest, resulting in pneumothorax and hemopneumothorax. In cases of suspected bladder injury,

TABLE V
RELATION OF PATHOLOGY TO MORTALITY

Organs	Stab Wounds Combined			Stab Wounds Pure			Gunshot Wounds			Nonpenetrating Wounds		
	No.	Died	Per Cent	No.	Died	Per Cent	No.	Died	Per Cent	No.	Died	Per Cent
Liver.....	29	8	27	22	7	32	3	1	33	4	1	25
Evisceration.....	23	4	17	..	..	..	1	0	..	..	..	..
Vascular injury.....	19	5	26	..	..	..	7	5	71	..	..	..
Stomach.....	15	5	33	8	2	25	2	2	..	..	..	..
Small intestine.....	15	7	46	5	2	40	9	7	78	5	3	60
Large intestine.....	12	1	8	9	1	11	7	5	71	..	..	..
Gallbladder.....	3	1	33	1	0	..	1	1	..	..	..	..
Urinary bladder.....	1	0	..	1	0	..	..	..	..	1	0	..
Kidney.....	1	0	..	1	1	..	..	..	..	..	..	..
Pancreas.....	1	0	..	..	..	..	..	..	..	..	..	..
Spleen.....	..	..	..	..	..	..	1	1	..	9	4	66
Blood spillage.....	52	18	35	..	..	..	13	10	77	13	6	46
Retroperitoneal hematoma.....	5	2	40	..	..	..	3	2	66	2	1	50
Shock.....	30	12	40	..	..	..	..	..	..	..	..	..
Without shock.....	49	8	16	..	..	..	..	..	..	..	..	..

There were sixteen gunshot wounds of the abdomen. One of these patients died before he could be operated upon. Thirteen of the remaining fifteen had multiple intra-abdominal injuries. All had signs and symptoms pointing to the abdomen with the exception of two patients. One of these was in severe shock on admission.

All of the twenty patients with nonpenetrating intra-abdominal injury had signs and symptoms pointing to abdominal injury prior to operation, probably because these patients would not be operated upon the absence of localizing symptoms.

Pneumoperitoneum, as demonstrated by x-ray, and the diagnostic aspiration of blood on puncture of the abdomen are valuable corroborative evidence of intra-abdominal injury when present; but these are so often absent in the presence of real intra-abdominal injury that both measures

catheterization of the bladder and the injection of a radio-opaque substance may be used to delineate the contour of the bladder.

Twenty of the seventy-nine patients with penetrating stab wounds of the abdomen treated, twelve of the sixteen gunshot wounds, and nine of the twenty nonpenetrating intra-abdominal injuries died, giving a mortality rate of 25, 75 and 45 per cent, respectively, for the three groups.

It is interesting to study the relationship between the organ injured and the mortality rate. (Table v.) The mortality rate in stab wounds for cases in which only one organ was injured is compared with the mortality rate in those cases in which the organ injured was associated with other intra-abdominal injuries. In general, the mortality rates for the pure and combined

injuries ran essentially parallel. The stomach and small intestine injuries in both groups had higher mortality rates than injuries of the large intestine, a fact which is rather startling. The mortality rate for injuries of the liver was about 30 per cent in both groups. The traumatic eviscerations revealed the relatively low mortality rate of 17 per cent. Forty per cent of the patients who entered the hospital in shock died as compared to a mortality of only 16 per cent for those admitted without shock. It is interesting to note that the average intraperitoneal spillage of blood was 600 cc. in the patients who died and 350 cc. in the surviving group.

In gunshot wounds of the abdomen, the mortality rate was so high, and the presence of multiple injuries so numerous, that no worthwhile deductions bearing on the prognosis from a statistical study of the injuries to the different organs could be reached.

In the nonpenetrating intra-abdominal injuries, injuries of the spleen showed a mortality rate of 66 per cent, the small intestine 60 per cent, and the liver 25 per cent.

The average stay in the hospital for the group that survived was 19.2 days; and for the group that died was 4 days. The average hospital stay was 18.9 days for the patients with stab wounds who survived, 18 days for the surviving gunshot wounds, and 24 days for the surviving nonpenetrating injuries.

All the patients with intra-abdominal injuries were given morphine on admission to the hospital. The patients with penetrating stab wounds also received 1,500 units of tetanus antitoxin, and those with gunshot wounds 3,000 units. If the patient was unable to void, he was catheterized in order to evaluate injury to the urinary passages, and to assure an empty bladder at operation. The pulse, blood pressure, and respirations were noted every hour to detect the onset of shock, concealed hemorrhage, or tension pneumothorax. The blood was routinely typed. If the patient was in

shock on admission, he was placed in Trendelenburg position, and administered hot blankets and hot water bottles, and an infusion of 5 per cent glucose in normal saline was started. In the cases admitted in 1941, cortate was also injected. If blood was available and the patient's condition warranted it, he was given a transfusion. The patient was then prepared for operation. All patients with intra-abdominal injuries are operated upon as soon as they can be put in condition for operation, and at the earliest possible moment.

The delay in the operation enforced by the adequate preoperative treatment of shock, need not, if not unduly prolonged, materially increase the risk of infection now that the intraperitoneal use of sulfonamides is quite generally practiced. There were nine patients who were operated upon five or more hours after admission because of their refusal to consent to operation. Three died and six recovered, a mortality rate of $33\frac{1}{3}$ per cent which is not in excess of the prevailing mortality rate, since one of these three patients operated upon twelve hours after admission for a perforation of the jejunum died of peritonitis. The other two died of shock and hemorrhage.

If the patient showed signs of respiratory distress, a pneumothorax reading was taken, and underwater drainage instituted if necessary. In cases of associated chest and abdominal injuries, the underwater drainage set-up was always kept ready for instant use in case dyspnea developed.

Open cone ether was used as the anesthetic of choice in the majority of the 115 cases with gas, oxygen, and ether next in order of frequency. Spinal anesthesia was used in only four cases, since the frequent presence of shock and intra-abdominal hemorrhage constituted a decided contraindication to its use. Furthermore it has the tendency to increase intestinal peristalsis and would, therefore, have the tendency to increase the gastrointestinal tract. Local 1 per cent novocaine anesthesia was used in three cases, in which there was a complicating pulmonary tuberculosis.

In all cases of penetrating intra-abdominal injury it is desirable to visualize the zone of injury. This is relatively easy in the stab wounds, and more difficult in the gunshot wounds. In the latter, the bullet must be located by roentgenograms and its location studied in relation to the wound of entry. The wound of entry may be distinguished from the wound of exit by the fact that it is smaller and is associated with an area of abrasion and contusion. The wound of exit is keyhole in shape and larger in size. A bullet which has penetrated any part of the peritoneal cavity in any direction will almost certainly pierce the gastrointestinal tract. The only exception is that of an anterioposterior bullet path across the top of the right subdiaphragmatic space.

A crushing or blunt force may injure the intra-abdominal viscera without leaving any marks in the abdominal wall.

The incision used is the one which most adequately exposes the zone of injury. If there is only one abdominal wound, the incision should either include or be placed near this wound. The incision is carried down to the peritoneum, which is entered in all gunshot wounds, and in all nonpenetrating injuries. In stab wounds, if penetration of the peritoneum is not readily found, peel away the peritoneum and look for the perforation in the peritoneum or for signs of intraperitoneal hemorrhage. If no signs of penetration are found, the abdominal wall is closed and a Penrose drain inserted down to the peritoneum. If an opening in the peritoneum is noted, the peritoneal cavity is opened and a thorough exploration carried out. In the above series, a paracostal incision was used seven times, a transverse incision once, and in another case the abdomen was explored through the enlarged abdominal wound. The incision used in the remaining cases was a rectus muscle splitting incision placed over the zone of injury. The incisions must be adequate so as to favor wide exposure and thorough and rapid exploration.

Once the abdomen is opened, the aim of the surgeon must be to stop hemorrhage, and to stop any further spillage from rup-

ture or penetration of a hollow viscus. If hemorrhage is a feature of the operative findings, the blood should be suctioned off, and lap pads should be used freely to soak it up, so as to visualize the source of bleeding. The blood tends to accumulate in the lumbar gutters, from which it gravitates to the pelvis. The pelvis must be aspirated dry, otherwise the blood tends to well up into the lumbar gutters and obscure the source of the bleeding. If the bleeding point is not immediately apparent, proceed systematically to the examination of all the solid organs that could possibly come within the zone of injury. Palpation may be sufficient, but it is better to visualize the organ if possible. The search for the bleeding point may then be continued by the systematic examination of the gastrointestinal tract from beginning to end, also noting any existing perforation of the bowel in the meanwhile. Any bleeding noted in the omentum, mesentery, or major blood vessels must be controlled. If any portion of the intestine is separated from its blood supply, it must be resected. Where hemorrhage is not a feature of the operative findings, a search must nevertheless be made for perforations of the gastrointestinal tract from beginning to end. A hint as to the organ injured is often found as soon as the abdomen is opened. A fecal odor, or the actual presence of feces will direct attention to the large intestine or rectum; bile will direct attention to the gallbladder or to the upper gastrointestinal tract, thin serous fluid to perforations of the stomach and small intestine, and urine to the bladder.

The abdomen is usually closed in layers; in only two of our cases was closure effected by through-and-through sutures. The wounds in the peritoneum are usually closed from within the abdomen, and a Penrose drain or a wick of gauze placed in the wound of entry or exit.

Intraperitoneal drains were used in sixty or more than half of our cases. They were used whenever the peritoneum had been badly contaminated by gastrointestinal spill, or when oozing from injury to the solid organs, or from vascular injury might

be expected to continue postoperatively. Of the sixty drained, thirty-five were drained because of spillage from perforations of the gastrointestinal tract, twenty were drained because of the possibility of continued oozing from injury to solid organs or from vascular injuries; and five were drained because of contamination of the peritoneal cavity from traumatic evisceration of intestine and omentum. The tendency lately has been to drain less and less and to rely on a painstaking toilet of the peritoneum, meticulous hemostasis and the intraperitoneal use of sulfonamides. Ten to 12 Gm. of sulfanilamide or sulfathiazole were used in our cases.

It may now be worth while to consider special points in the treatment of each organ. There were twenty-nine stab wounds, three gunshot wounds and four nonpenetrating injuries of the liver, in all thirty-six wounds of the liver, with a mortality of 27, 33, and 25 per cent for each group, respectively, and of 27 per cent for the group as a whole. (Table v.) Twenty of these injured livers were treated by suture with a mortality of 20 per cent, and sixteen were treated by packing with a mortality of 37 per cent. The greater mortality for the group treated by packing may be due to the fact that this treatment was reserved for the more severe injuries of the liver. There were in all ten deaths in patients with injury of the liver; four died from shock, four from pneumonia, one from peritonitis, and one from liver death.

There were eleven lacerations of the spleen from all causes. All were treated by splenectomy, six recovered, and five died, giving a mortality rate of 45 per cent for the group. All of the five that died, did so from shock and hemorrhage. Two died on the operating table, one of these dying from a rupture of the diaphragm incident to the removal of the spleen.

There were two lacerations of the kidney in the series, one a patient with a gunshot wound treated by gauze tamponade who died from peritonitis; and the other a patient with a stab wound of the kidney and pancreas who recovered. The kidney

was sutured, and the pancreas drained in this case. In injuries of the kidney, the peritoneum overlying the kidney must be sutured, if penetrated, to prevent leakage of urine into the peritoneal cavity. If the kidney wound is packed, the gauze packing may be brought out through a lumbar wound made by the surgeon, or through a convenient wound of entry or of exit. Nephrectomy is only indicated in extensive damage to the hilum of the kidney or with uncontrollable hemorrhage.

The group of vascular injuries included bleeding from the lesser, and greater omentum, mesentery, major blood vessels, and retroperitoneal hematoma. There were nineteen cases in which the vascular injury was due to stab wound with five deaths, and seven cases in which the injury was due to gunshot with five deaths, giving a mortality of 26 and 71 per cent for the two groups, respectively. Of the ten patients who died, five died from shock, four from peritonitis, and one from pneumonia. In this group of vascular injuries were ten cases of retroperitoneal hematoma, with five deaths, a mortality of 50 per cent for the group. Of the five who died, four died from shock, and one from peritonitis. It may be noted in passing that it is unwise to explore these retroperitoneal hematomas unless they expand rapidly in size, as to do so may release the tamponade and result in violent and uncontrollable hemorrhage with quick exitus of the patient.

There were four gallbladder injuries with two deaths. Both of the patients who died had multiple injuries of the liver, stomach and small intestine, and death was in all probability due to the associated injuries rather than to the gallbladder injury. Of the two patients with gallbladder injuries who recovered, one had a nonpenetrating wound of the serosa which was sutured, and in the other case the gallbladder was drained through the stab wound. The patients who died were similarly treated. Extensive injuries of the gallbladder may be treated by cholecystectomy.

There were fifteen stab wounds of the stomach, eight of which were pure injuries

with a mortality rate for the two groups of 33 and 25 per cent, respectively. There were also two patients with gunshot injuries of the stomach who died. The wounds were all sutured and covered with omentum when possible. The posterior wall of the stomach must always be examined when a wound of the anterior wall of the stomach is found. This may be done through an enlargement of the wound on the anterior wall of the stomach, or by opening the lesser sac through the gastrocolic, or gastrohepatic omentum, or through the transverse mesocolon. There were seven deaths in the group; five died from shock, one from pneumonia and one from peritonitis.

There were fifteen stab wounds of the small intestine, five of which were pure injuries. The mortality rates for the two groups were 46 and 40 per cent respectively. There were also 9 gunshot intestinal injuries with seven deaths; and five non-penetrating ruptures of the intestine with three deaths. Of the seven deaths from stab wounds, two were from shock, two from pneumonia and pulmonary atelectasis and three from peritonitis. Of the seven deaths from gunshot injuries four were from shock, two from peritonitis and one from delayed sepsis and peritonitis from an intestinal fistula. Of the three deaths from nonpenetrating injury to the small intestine, two were from peritonitis and one from shock. All intestinal wounds were sutured with the exception of those in three cases. One of these was a stab wound with injury to the mesentery necessitating resection of a portion of the ileum with side-to-side anastomosis of the intestine. This patient died. The other two were gunshot injuries in which it was found necessary to resect a portion of the ileum, and were also treated by side-to-side anastomosis of the intestine. One of these patients died and the other recovered. The two patients who died did so because of peritonitis. Considering the deaths from all types of intestinal injury it may be noted that of the seventeen deaths, nine were from peritonitis, one from sepsis and seven from shock. The more recent

general use of the sulfonamides intraperitoneally may be expected to reduce the deaths materially from infection in this group.

There were twelve stab wound injuries of the large intestines with one death, and seven gunshot injuries with five deaths giving a mortality rate of 8 and 71 per cent, respectively, for the two groups. All these patients were treated by suture of the perforation. The low mortality rate for stab wounds of the large intestines is rather startling, as is the fact that in this series, it is much lower than the mortality for stab wounds of the small intestines. In the one death from a stab wound of the colon in this group, the cause of death was pneumonia. Of the five deaths following gunshot wounds, two died from shock and three from peritonitis.

There were twenty-three traumatic eviscerations, eighteen of which were of the omentum, four of the small intestines, and one of the transverse colon. There were only four deaths in this group, a mortality rate of 17 per cent. Two died from pneumonia and two from peritonitis. In all cases, the eviscerated portion of the omentum was resected and the eviscerated loops of intestine were flushed thoroughly with normal saline solution and returned to the abdomen.

To summarize, there were forty-two deaths in the 115 intra-abdominal injuries in this series. Twenty-one were due to shock, eight to pneumonia, one to pneumonia and pulmonary atelectasis, eleven to peritonitis and one to liver death. It is to be noted that shock and infection are the conditions to be combatted if we are to reduce the mortality rate materially.

Postoperatively, the patients were given adequate amounts of morphine or pantopon for sedation. Those without perforation of the gastrointestinal tract were put on clear fluids for two or three days, then given a soapsuds enema, and put on a soft diet if no signs of sepsis or peritonitis had supervened. Those who were in shock, or who developed shock after operation were continued for several days on intravenous

fluids, usually 5 per cent glucose and saline, fortified with transfusions of citrated blood if necessary. There were forty patients who were admitted in shock, and twenty-five more who developed shock postoperatively in the entire series of 115 cases of intra-abdominal injury. The patients with stab wounds of the abdomen who lived received slightly more, and those who died received slightly less than 600 cc. of blood at transfusion. Ten patients admitted in shock received no blood at all, four getting well without transfusions and six dying before the blood could be procured. The patients with gunshot wounds who recovered got 1,000 cc. of blood; those who died received about 700 cc. of blood. The patients with nonpenetrating intra-abdominal injuries who recovered received an average of 700 cc. of blood, and those who died received an average of 900 cc. of blood. Those who died got less blood for the treatment of shock than the patients who lived, because they died before a sufficient amount of blood could be procured.

We realize that the amount of blood used in the treatment of shock in these cases falls considerably short of the amount that we would desire to use; but the amount used is necessarily limited by the amount on hand in the blood bank. Adrenal cortical extract should be used in addition to the transfusions of whole blood and plasma.

Patients with perforations of the gastrointestinal tract were treated as potential cases of peritonitis. They were kept adequately sedated with morphine or pantopon, and were kept on intravenous fluids with nothing by mouth until indicated. A Levine or a Miller Abbott tube was used postoperatively and in peritonitis cases, always combined with Wangenstein drainage. Those patients had been treated with sulfonamides intravenously until the danger of infection had passed. Vitamin c was given in large doses in order to promote wound healing.

The patients who developed pneumonia had their sputa typed and were treated with oxygen and the sulfonamides. Pulmonary atelectasis was treated by the

inhalation of oxygen and carbon dioxide, frequent changes in position and bronchoscopy where indicated.

CONCLUSIONS

1. Abdominal signs and symptoms were present in all but ten of the 115 cases of intra-abdominal injury included in this series.

2. Abdominal signs and symptoms in intra-abdominal injury may be masked by shock and alcoholism. Of the ten patients who were asymptomatic, five were in severe shock on admission.

3. All patients are to be operated upon at the earliest possible moment, consistent with the adequate preparation of the patient and the adequate treatment of shock.

4. The importance of transfusions of citrated whole blood and plasma is stressed.

5. All cases must be thoroughly explored through adequate incisions.

6. The use of sulfonamides intraperitoneally and intravenously is indicated in all cases in which the peritoneum is contaminated from within or without.

7. All patients with gastrointestinal perforation are to be treated as cases of potential peritonitis, receiving Ochsnerization, blood and sulfonamides.

REFERENCES

- EISEBERG, H. B. Diagnosis and treatment of penetrating abdominal wounds. *Am. J. Surg.*, 5: 145, 1928.
- GORDON-TAYLOR, G. Abdominal injuries and their recipients. *Brit. J. Surg.*, 26: 217, 1938.
- LORIA, F. L. Prognostic factors in abdominal gunshot wounds. *New Orleans M. & Surg. J.*, 80: 283, 1927-1928.
- MITCHINER, P. H. and COWALL, E. M. Air raid: abdominal and pelvic injuries. *Lancet*, 1: 469, 1939.
- OBERHELMAN, H. A. and LECOUNT, E. R. Peace-time bullet wounds of the abdomen. *Arch. Surg.*, 32: 373, 1936.
- SELLECK, W. M. Penetrating wounds of the abdomen. *Am. J. Surg.*, 118: 500, 1923.
- STORCK, A. H. Penetrating wounds of abdomen. *Ann. Surg.*, 3: 775, 1940.
- STORCK, A. H. Gunshot wounds of the abdomen. *South. Surg.*, 8: 148, 1939.
- WILLIS, B. C. Shotgun wounds of abdomen. *Am. J. Surg.*, 28: 407, 1935.
- WILSON, FRANK C. Gunshot wounds of the abdomen. *South. Med. J.*, 27: 805, 1934.
- WRIGHT, L. T., WILKINSON, R. S. and GASTER, J. L. Penetrating stab wounds of the abdomen and stab wounds of the abdominal wall. *Surgery*, 6: 241, 1939.

SOLITARY CYST OF THE KIDNEY*

REPORT OF TWO CASES

LOWRAIN E. McCREA, M.D.

Associate Professor of Urology, Temple University Medical School;

Attending Urologist, Philadelphia General Hospital

PHILADELPHIA, PENNSYLVANIA

SOLITARY cyst of the kidney, although uncommon, is not as rare a clinical entity as is generally conceded. In a total of 78,518 admissions to Philadelphia General Hospital, between the years of 1939 and 1941, inclusive, eight solitary cysts of the kidney were observed. Of these eight cases, five were in association with other renal pathological disturbances. The two cases to be described came under personal observation on the Urological Service at Temple University Hospital. Both cases were diagnosed preoperatively and were proved at operation.

The first recorded instance of a diagnosis of solitary renal cyst was that of Fabricius de Hilden, who died in 1634. In 1861, Henry Thompson reported an enormous sac connected with the kidney, which was repeatedly emptied by tapping. Since that time there are numerous references in the literature. Undoubtedly, many instances of solitary cyst formation are unrecorded. Many have been discovered at autopsy or during surgical procedures.

A solitary cyst of the kidney is usually of large size, unilateral and unilocular. These cystic formations are usually observed in middle life, although many cases on record have been seen in early adult life and childhood. Hepler considers . . . "The average age incidence of 45 years, a period when vascular lesions as arteriosclerosis, endarteritis, aneurisms, infarcts and acquired lesions, such as tumor, are common."

CASE REPORTS

CASE 1. B. U., a female, white, age forty, presented a history of being well until one week

before admission, at which time she experienced a sharp pain in the right upper abdominal quadrant, radiating toward the genitalia. The pain continued for about twenty-four hours. Following this, she had a feeling of discomfort over the right side. After this attack and before admission to the hospital, she had two other attacks of severe pain, which lasted only a few hours. Her past medical history was negative and her family history irrelevant. On admission, a large mobile mass was palpable in the right upper quadrant. This mass moved on respiration. It was not painful to palpation. Urinalysis, on admission, showed no red cells and two to three leukocytes per field. Four days after admission, a catheterized urine specimen showed innumerable red blood cells. Retrograde pyelography revealed a left ureter and kidney that appeared normal. The right ureter was displaced anteriorly and to the left, so that it reached almost the midline of the abdomen. (Fig. 1.) The kidney calices and pelvis presented an abnormal appearance, which suggested that the kidney had become rotated. A large, soft, tissue mass on the right side was discernible and appeared to be connected with the right kidney. A diagnosis of solitary cyst was made, which was confirmed at operation. At operation the cyst was evacuated and the sac resected from the kidney parenchyma. Hemorrhage was readily controlled. There was little compression atrophy of the kidney.

CASE 11. F. K., nineteen years of age, a male, white, presented a history of recurrent attacks of hematuria over a period of three years. A diagnosis of renal tumor had been made previous to admission. On admission, the urine was cloudy and the urinalysis revealed countless red blood cells. The blood picture was normal other than a leukocytosis of 16,300. Blood Wassermann was negative. At cystoscopy the bladder was negative. Indigo-carmin, following intravenous administration, was elim-

* From the Department of Urology, Temple University Medical School.

inated in four minutes from both ureteric orifices, of good ejection and intensity. An x-ray examination revealed a partially calcified

Davis, Kampmeier and others. Lawrence Smith, Professor of Pathology, Temple University Medical School, is of the opinion



FIG. 1. Retrograde pyelogram showing the line of the ureter displaced toward the midline. The pelvis and calices present a definite blunted appearance.



FIG. 2. Retrograde pyelogram of the right kidney showing a marked elongation of the lower calyx and considerable blunting of the upper calyx. Adjacent to the kidney can be seen an irregular ovoid mass showing varying degrees of calcification.

mass in the region of the right kidney. Retrograde pyelography revealed that the large calcified mass was causing moderate compression of the renal calices from their lateral aspects. (Fig. 2.) A diagnosis of solitary cyst with calcification was made. This was substantiated at operation. Nephrectomy was deemed advisable due to the marked compression of the lower pole of the kidney. (Fig. 3.) The diagnosis of solitary renal cyst with calcification was confirmed by histologic examination. (Fig. 4.) Subsequent examinations have revealed the presence of an increasing hypertension which, in a way, was reflected to the time of original admission, when the blood pressure was found to be 130/90. The urinary findings have subsequently been found to be negative.

The etiology of solitary cyst of the kidney has never been established. There are many varied theories as to their origin. That such cysts are congenital in origin is supported by such men as Hildebrand,

that solitary renal cysts are of congenital origin. The fact that they occur usually in middle life is supported by the fact that the few secreting glomeruli found in the walls of the cyst possess poor secreting ability. This results from the fact that embryologically they are not connected normally to the collecting renal tubules. The pressure of the secreted fluid within a thick, limiting membrane, is such to prevent rapid secretion from an otherwise abnormal glomeruli. It takes years before these cysts are of sufficient size to warrant attention or produce clinical symptoms. Caulk believed that . . . "Those who contend that all kidney cysts are of congenital origin are unquestionably making a statement which is unjustifiable." He was also of the opinion that the majority of solitary renal cysts belong to a class of retention cysts, following obstruction. Hepler believes that tubular obstruction associated

with anemia from interference with local blood supply is responsible for the formation of these cysts. He has been able,



FIG. 3. Specimen removed at operation, consisting of the kidney and the calcified cyst. Considerable pressure atrophy was noted in the lower pole of the kidney.

experimentally, to produce a renal cyst in rabbits by the blocking of the renal papillae by fulguration with simultaneous ligation of the posterior branch of the renal artery. Clinically, he believes that analogous tubular obstruction and circulatory disturbances may be produced by various pathological conditions, such as an obliterating endarteritis with peritubular sclerosis and infarct from embolus or thrombosis. He further states . . . "It would seem more reasonable to suppose that they are related in some way to the acquired renal lesions which are more common in middle life." Herbst and Polkey believe that in some instances . . . "These cysts may be due to hyperplasia of part of the elements derived from the excretory ducts, viz., that small localized tubular congenital anomalies may remain latent until middle life when they become aggravated by the circulatory disturbances which occur at this time, (arteriosclerosis, emboli, infarcts). The anemia caused by these circulatory changes may

have something to do with the blowing out of the larger cysts."

Solitary cysts of the kidney, in contradistinction to polycystic disease or retention cysts of the kidney, are usually unilateral. On occasion, they may be multilocular. Such a condition is rare. Meland and Braasch reported six such cystic formations and were able to find only four previous reports. In solitary renal cysts, either side may be affected. The condition may be found in either sex, in relatively equal occurrence. Any portion of the kidney may be the site of the cyst. However, from a summary of the cases reported, these cysts are more frequently observed at the lower pole of the kidney; next in frequency at the upper pole and most infrequently in the body of the kidney. They may occur on the anterior surface or the posterior surface of the kidney. In size, they may vary from one of a few cubic centimeters in capacity to one of enormous proportion. One of such capacity was described by G. W. Fish, which contained ten liters of fluid. The largest recorded cyst was that reported by Cassioli, which contained twelve liters of fluid. In true solitary cyst, there is no communication between the cyst formation and the renal pelvis or calices. The cyst wall is usually densely adherent to the renal parenchyma and may show remnants of compressed glomeruli. The adjacent renal parenchyma is usually compressed as a result of pressure exerted by the cyst. The cyst wall is composed of dense fibrous tissue which may show extensive areas of calcification. A serous solitary cyst contains a clear, yellowish and watery fluid, composed of albumin, chlorides, epithelial cells, a few leukocytes and traces of urea. The contents of some cysts may be of a hemorrhagic nature and may even contain old clotted blood.

SYMPTOMS

There is no symptom or symptom complex characteristic of solitary cysts. A solitary cyst may produce no symptoms whatsoever, but may be discovered acci-

dently in routine examination. This is due in part to the slow growth of the cyst and the fact that there are no symptoms or

tion. The tumor is usually unilateral, firm, smooth, yet elastic. The mass does not appear fixed in the loin as it presents a

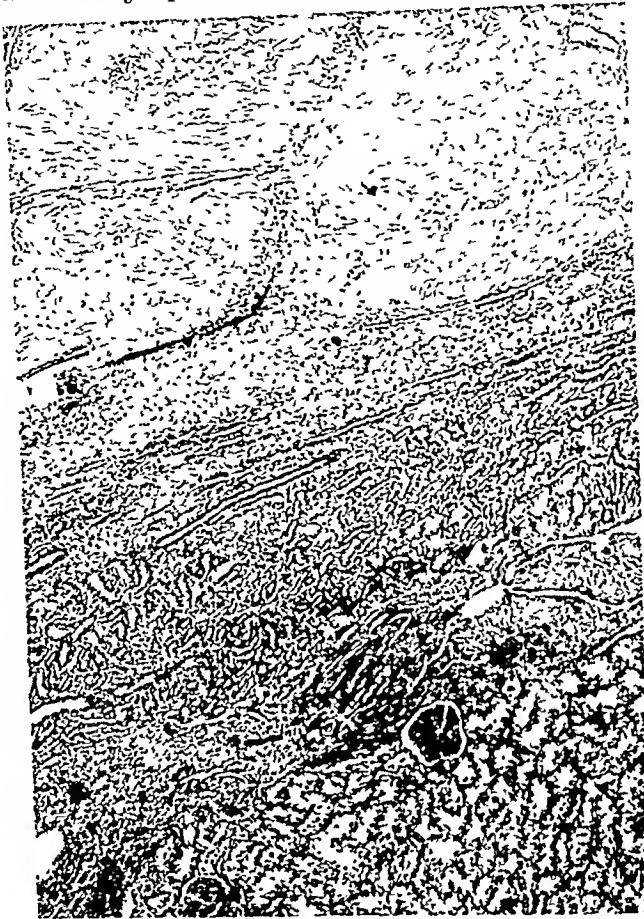


FIG. 4. Microphotograph showing the dense hyalinized fibrous cyst wall and the contiguous compressed and elongated kidney tubules.

group of symptoms that are characteristic or constant. In some instances, there is only a feeling of discomfort or weight in the loin, or a distinct dull pain is apparent. In others, the pain may be of a colicky nature—the pain of renal colic. The pain so described is often associated with other surgical lesions and is, therefore, not characteristic of solitary cyst. Occasionally, as in one of the cases here reported, hematuria is the only symptom. The content of the cyst may be of a hemorrhagic nature, but that in itself does not warrant the appearance of blood in the urine, as there is no point of communication between the cyst and the renal pelvis. Being without evident symptoms, it may be the presence of the abdominal mass which first attracts atten-

definite respiratory excursion. Individual renal function tests are usually normal and it is only after extreme pressure atrophy occurs that unilateral reduction of renal function becomes apparent. The blood chemistry and the urine are usually negative although blood cells in varying numbers may be seen in some instances.

DIAGNOSIS

Due to the vague nature and inconsistent character of the symptoms, a preoperative diagnosis may be difficult or even impossible. The negative urine findings, the normal blood chemistry, and the presence of a palpable mass are confusing. Hematuria, inconstant as it is, or pain, constant, dull or severe, as occasionally observed, is not

pathognomonic. X-ray offers the greatest diagnostic assistance at the command of the surgeon. The plain roentgenogram of the abdomen may reveal a cyst adjacent to a kidney, presenting an ovoid or spherical appearance. This is particularly true when calcification of the wall is present. Urography, although it may be normal, usually shows some distortion of the renal pelvis or calices as a result of pressure. (Figs. 1 and 2.) Cysts on the upper pole and the body of the kidney are more apt to affect the normal contour of the pelvis than those cyst formations located at the lower pole. Although a hydronephrosis may occur as a result of ureteral compression by the cystic mass upon the ureter, it is an unusual finding. The pyelogram will generally show a flattened, elongated appearance, or an elongation of a single calyx. (Fig. 2.) The differential diagnosis of solitary cyst of the kidney must exclude nearly all forms of renal disorders, especially renal neoplasm and hydronephrosis. Although it may be difficult to exclude the presence of renal neoplasm, the normalcy of the urine findings and individual renal function tests is of the utmost importance in differential diagnosis. The shadow on the roentgenogram, particularly when it can be well outlined, should be of definite diagnostic importance. In the presence of a solitary cyst, the total absence of pyelectasis and of urinary retention within the renal pelvis, and the relative position of the shadow of the cyst to the renal pelvis and calices should be such as to make possible the differentiation from hydronephrosis.

The prognosis is good, although there are many factors that may enter the clinical picture. The presence or absence of complicating infection and calculi must be considered. However, the mortality should be no greater in this condition than other individuals subjected to nephrectomy when indicated.

TREATMENT

Treatment of solitary cyst is entirely surgical and should be instituted as early

as possible to prevent secondary atrophic destruction of kidney tissue, resulting from the pressure of the cyst upon the renal parenchyma. Surgery is feasible unless operation is contraindicated by associated disease, making such surgical procedures inadvisable. Nephrectomy is indicated only when atrophic destruction is so extensive that to permit the kidney to remain is inadvisable. Excision of the cyst is by far the method of choice. To establish the line of cleavage between the cyst wall and the parenchyma of the kidney, resecting the cyst *in toto* is the logical procedure, when possible. However, nephrectomy may be necessary following such procedure, because of uncontrollable hemorrhage, or may be deemed advisable because of the extensive destruction of kidney tissue.

SUMMARY

1. The etiology of solitary renal cyst is not known. It is controversial whether such cysts are congenital or acquired.
2. Solitary renal cyst, although uncommon, is not rare in occurrence.
3. The condition occurs with equal frequency on the right or left side.
4. Occurrence is relatively equal in either sex.
5. The most frequent site of origination is the lower pole of the kidney. Next in frequency is the upper pole and lastly the body of the kidney.
6. The condition may be observed at any time of life, but is not commonly seen in the first two decades, but is most common between the ages of thirty and fifty years.
7. The most logical treatment is that of resection of the cyst. However, nephrectomy may be advisable because of extensive destruction of the kidney, or because of uncontrollable hemorrhage following resection of the cyst.

REFERENCES

- ABEL, I. Solitary cyst of the kidney. Report of a case with review of the literature. *Urol. & Cutan. Rev.*, 20: 617, 1916.
- ALLEN, C. D. and RAGSDALE, J. W. Solitary cyst of the kidney. *Am. J. Surg.*, 29: 311, 1935.

- ANDRESEN, K. Roentgenology of solitary cysts. *Roentgenpraxis*, 8: 505, 1936.
- ARCHER, F. B. Antiseptic nephrectomy by abdominal section; recovery. *Lancet*, 1: 1070, 1882.
- ASCHNER, P. W. Solitary cyst of kidney. *Am. J. Surg.*, 5: 83, 1928.
- BARNEY, J. D. Discussion. *New England J. Med.*, 199: 278, 1928.
- BEGG, R. C. Solitary hemorrhagic cysts of the kidney. *Brit. J. S.*, 13: 649, 1926.
- BEVERS, E. C. A renal cyst causing chronic intestinal obstruction. *Brit. M. J.*, 1: 702, 1914.
- BOCKENHEIMER, C. Cystischer Tumor bei Hufeisenniere; durch Operation entfernt; Heilung. *Berl. klin. Wchnschr.*, 48: 1345, 1911.
- BOCKUS, H. L., KROHN, S. E. and MULLEN, E. A. Solitary cyst of the kidney; case. *Urol. & Cutan. Rev.*, 44: 448, 1940.
- BOLYARSKIY, N. N. Solitary cyst of the left kidney. *Nory, kbr. arkhiv.*, 41: 267, 1938.
- BOYLAN, C. E. Solitary cyst of the kidney; discussion and case report. *Illinois M. J.*, 71: 490, 1937.
- BREWER, G. E. Simple cyst of kidney. *J. A. M. A.*, 50: 718, 1908.
- BRIN, H. Des cystes non hydatiques du rein; symptômes, diagnostic et traitement. *Asso. Fran. d'urolog. Proc.-oert.*, 15: 33, 1911-1912.
- BYRUM, J. M. Solitary cyst with calcification; case. *J. Oklahoma M. A.*, 24: 365, 1931.
- CABRERA, E. G. Solitary serous cysts of the kidney. *Bol. Asoc. méd. de Puerto Rico*, 1: 461, 1932.
- CAHILL, G. F. Solitary cyst with resection. *Am. J. Surg.*, 8: 1290, 1930.
- CAMPBELL, A. Case of cystic tumor attached to kidney simulating ovarian disease; extirpation of kidney; recovery. *Edinburgh M. J.*, 20: 36, 1874.
- CARLING, E. R. Large solitary cyst of renal origin. *Brit. J. Surg.*, 22: 184, 1934.
- CARSON, W. J. Solitary cysts of the kidney. *Ann. Surg.*, 87: 250, 1928.
- CASSIOLI, C. Di una voluminosissima ciste solitaria del rene. *Riv. osp.*, 7: 151, 1917.
- CATTANEO, M. Solitary cyst of lower pole of right kidney following abdominal injury. *Boll. e. mem. Soc. piemontese di chir.*, 3: 830, 1933.
- CAULK, J. Obstructive calcareous papillitis; retention cysts of the kidney. *Tr. Am. A. Genit.-Urin. Surgeons*, 7: 228, 1912.
- CLUTE, H. F. Simple serous cysts of the kidney. *Surg. Clin. North America*, 4: 1453, 1924.
- COLSTON, J. A. C. Solitary cyst and papillary cystadenoma occurring simultaneously in one kidney. *J. Urol.*, 19: 285, 1928.
- COLSTON, J. A. C. Calcified cyst of the kidney. *Bull. Johns Hopkins Hosp.*, 51: 125, 1932.
- COOPER, S. Solitary cyst of the kidney. *Texas State M. J.*, 33: 697, 1938.
- CRABTREE, E. G. Discussion. *New England J. Med.*, 199: 278, 1928.
- CROSBY, A. H. Solitary cyst of the kidney. *New England J. Med.*, 199: 277, 1928.
- CUNNINGHAM, J. H. Large solitary and multiple cysts of the kidney. *Surg., Gynec. & Obst.*, 23: 688, 1916.
- DAMM, E. Solitary cysts. *Ztschr. f. urol. Chir.*, 102: 113, 1932.
- DAVIS, J. E. The surgical pathology of malformations in the kidney and ureters. *J. Urol.*, 20: 283, 1928.
- DEAN, A. L. Treatment of solitary cyst of the kidney by aspiration. *Tr. Am. A. Genito-Urin. Surgeons*, 32: 91, 1939.
- DE FARIA, G. and FIALHO, A. Solitary cyst partially calcified and ossified; value of excretory urography in diagnosis; case. *Hospital, Rio de Janeiro*, 14: 241, 1938.
- DOZSA, E. Clinical data on large serous cysts of kidneys. *Ztschr. f. urol. Chir.*, 22: 70, 1927.
- DOUGLAS, J. Solitary cyst of the kidney. *Ann. Surg.*, 76: 656, 1922.
- FANG, H. C. Solitary cyst of the kidney. *Chinese M. J.*, 53: 221, 1938.
- FISCHER, K. Solitary cysts of the kidney 3 cases. *Arch. f. klin. Chir.*, 185: 356, 1936.
- FISH, G. W. Large solitary serous cysts of the kidney. Report of 32 cases including 2 cases cured by aspiration and instillation of 50% dextrose solution. *J. A. M. A.*, 112: 514, 1939.
- FORBES, R. D. Solitary cyst of the kidney. *Surg. Clin. North America*, 13: 1357, 1933.
- FOWLER, R. S. Simple serous cysts of the kidney. *New York M. J.*, 940: 1109, 1911.
- FUENTES, B. V., SCHUNK, A. and BUNO, W. Large solitary cyst of the kidney; case. *Arch. urug. de med., cir. y. especialid.*, 18: 541, 1941.
- FULLERTON, A. Solitary cysts of kidney. *Brit. J. Surg.*, 14: 629, 1927.
- GEISINGER, J. F. Solitary cyst of the kidney. *Urol. & Cutan. Rev.*, 40: 778, 1936.
- GRAVES, R. C. Congenital solitary kidney with large solitary cyst. *J. Urol.*, 23: 555, 1930.
- GREENBERG, B. E., BRODNEY, M. L. and ROBINS, S. A. Solitary cyst of the kidney; review of co-existing pathology. *Am. J. Surg.*, 23: 271, 1934.
- GREENBERG, A. L. Right solitary renal cyst; left renal calculus. *J. Urol.*, 42: 87, 1939.
- GAULTIEROTTI, M. M. Solitary cysts of the kidney; clinical and roentgen study of 3 cases. *Urologia*, 6: 103, 1939.
- GUTIERREZ, R. Large solitary cysts of the kidney; types; differential diagnosis and surgical treatment. *Arch. Surg.*, 44: 279, 1942.
- HARE, C. J. Cystic kidney weighing 16 pounds. *Tr. Path. Soc. London*, 3: 131, 1850-1851.
- HARPSTER, C. M., BROWN, T. H. and DELCHER, A. Solitary unilateral large serous cysts of kidney. *J. Urol.*, 11: 157, 1924.
- HEPLER, A. B. Solitary cysts of the kidney. *Surg., Gynec. & Obst.*, 50: 668, 1930.
- HERBST, R. H. and POLKEY, H. J. Solitary renal cysts. *J. Urol.*, 37: 490, 1937.
- HERBST, R. H. and VYNALIK, W. J. Solitary serous renal cysts. *J. A. M. A.*, 96: 597, 1931.
- HERBST, R. H. and APFELBACH. Hyperplasia of kidney. *Surg., Gynec. & Obst.*, 61: 306, 1935.
- HIGGINS, C. C. Solitary cyst of the kidney. *Ann. Surg.*, 93: 868, 1931.
- HIGGINS, C. C. and LAVIN, E. J. Solitary cysts of kidney. *Radiology*, 23: 598, 1934.
- HILDEN, F. DE. Quoted by Kirwin.
- HINMAN, F. Principles and Practice of Urology. Philadelphia, 1935. W. B. Saunders Co.
- JOSEPH, M. A case of large solitary cyst of kidney. *J. Urol.*, 17: 245, 1927.
- JOSEPH, M. Large renal cyst (simulating solitary cyst). *J. Urol.*, 28: 297, 1932.

- JOWERS. Case of renal tumour; excision of kidney; death; remarks. *Lancet*, 1: 13, 1884.
- JUDD, E. S. and SIMON, H. E. Hemorrhagic cysts of the kidney. *Surg., Gynec. & Obst.*, 44: 601, 1937.
- JUNKER, H. Diagnosis of solitary cysts of the kidney. *Ztschr. f. Urol.*, 29: 709, 1935.
- KAMPMEIER, O. F. A hitherto unrecognized mode of origin of congenital renal cysts. *Surg., Gynec. & Obst.*, 36: 208, 1923.
- KEELING, J. H. Extirpation of kidney. *Brit. M. J.*, 2: 1299, 1882.
- KIRWIN, J. Calcified renal cyst. *J. Urol.*, 15: 273, 1926.
- KLOPP, E. J. and FETTER, T. R. Solitary cyst of kidney. *Surg. Clin. North America*, 14: 220, 1934.
- KRETSCHMER, H. L. Solitary cyst of the kidney. *J. Urol.*, 4: 567, 1920.
- KRETSCHMER, H. L. Solitary cyst; five cases. *J. A. M. A.*, 95: 179, 1930.
- KRUSEN, W. Cyst of kidney simulating ovarian cyst. *J. A. M. A.*, 11: 140, 1906.
- LADINSKI, L. J. Cystic tumor of kidney. *Med. Rec.*, 69: 524, 1906.
- LANSON, O. F. Solitary cyst of kidney. *Northwest. Med.*, 29: 206, 1930.
- LATTERI, S. Le cisti solitarie sierose del rene. (Studio clinico, anatomico-patologico e sperimentale.) *Arch. ital. d'urolog.*, 6: 113, 1930.
- LAZARUS, J. A. Solitary cyst of the kidney; 2 cases. *Urol. & Cutan. Rev.*, 35: 698, 1931.
- LIVERMORE, G. R. Solitary cyst of the kidney; case. *Memphis M. J.*, 10: 13, 1935.
- LOCKYER, C. Enormous renal cyst. *Proc. Roy. Soc. Med., London, Sec. Obst. & Gynec.*, 6: 97, 1912-1913.
- MCARDLE, J. S. Nephrorrhaphy and nephrectomy. *Dublin J. Med. Soc.*, 97: 207, 1894.
- MCCONNELL, A. A. Solitary cyst of the kidney. *Dublin J. Med. Soc.*, 4: 270-273, 1920.
- McKAY, R. W. Solitary cysts of the kidney. *South. M. J.*, 25: 234, 1932.
- McKIM, G. F. and SMITH, P. G. Solitary serous cysts of the kidney. *J. Urol.*, 12: 235, 1924.
- McMURTRY, L. S. Large cyst of the kidney; nephrectomy: recovery. *South. Clin.*, 16: 266, 1893.
- MEADOW, S. Nephrectomy for large cyst of kidney. *Brit. M. J.*, 2: 44, 1871.
- MELAND, E. L. and BRAASCH, W. F. Multilocular cysts of kidney. *J. Urol.*, 29: 505, 1933.
- MODINI, U. Solitary cyst of the kidney; case. *Clin. med. ital.*, 66: 540, 1935.
- MORTON, C. A. A clinical lecture on a case of gigantic retroperitoneal tumour, intimately connected with the kidney, which simulated ascites from tuberculous peritonitis; with a report of the pathology of the tumor, By E. V. Dunkley. *Lancet*, 2: 520, 1908.
- MOYNIHAN, G. B. A. Partial nephrectomy with three illustrative cases. *Brit. M. J.*, 1: 263, 1902.
- NASH, F. W. G. Solitary cyst of the kidney; case. *Brit. J. Urol.*, 6: 253, 1934.
- O'NEIL, R. F. Solitary serous cyst of the kidney, with the report of a case. *J. Urol.*, 14: 269, 1925.
- ORMOND, J. K. Solitary cyst of the kidney. *Am. J. Surg.*, 6: 241, 1929.
- PARMENTER, F. J. Type of cystic kidney amenable to surgical intervention. *New York State J. Med.*, 21: 73, 1921.
- PEDROSA, G. and R. Solitary cyst of the kidney; cases. *Vida nueva*, 44: 181, 1939.
- PURSWLOW, L. Cystic tumour of the kidney. *Brit. M. J.*, 1: 884, 1913.
- QUINBY, W. C., and BRIGHT, E. F. Solitary renal cysts; symptoms when situated at upper pole of right kidney. *J. Urol.*, 33: 201, 1935.
- RAVICH, A. and TURKELTAUB, S. M. Solitary cysts of the kidney. *Urol. & Cutan. Rev.*, 41: 261, 1937.
- ROBINSON, L. J. and WILDER, W. O. Simple solitary renal cyst. *J. Urol.*, 40: 10, 1938.
- SCIMIDT, A. Solitary cysts of the kidney. *Ztschr. f. Urol.*, 34: 476, 1940.
- SCHOLL, A. J. Hemorrhagic cysts of the kidney; case. *J. Urol.*, 41: 103, 1939.
- SCHULMAN, M. Unilocular cyst of the kidney. *New York M. J.*, 104: 218, 1916.
- SCHWARTZ, J. An unusual unilateral multicystic kidney in an infant. *J. Urol.*, 35: 259, 1931.
- SCHWYZER, A. Solitary cyst of the kidney; two cases. *Minnesota Med.*, 20: 474, 1937.
- SHIH, H. E. and WU, S. D. Solitary cyst of the kidney (case). *Chinese M. J.*, 59: 259, 1941.
- SMITH, L. D. Solitary serous renal cysts. *Illinois M. J.*, 52: 291, 1927.
- SMITH, G. G. Solitary cyst of the kidney. *Boston M. & S. J.*, 190: 691, 1924.
- STEVENS, A. R. Solitary cyst of the kidney; excision of cyst with suture of kidney. *Am. J. Surg.*, 19: 140, 1933.
- STEVENS, W. E. Solitary cysts; case in which preoperative diagnosis of cyst involving central portion of lone kidney was confirmed by operation. *Urol. & Cutan. Rev.*, 37: 698, 1933.
- STIRLING, W. C. Large solitary hemorrhagic renal cyst; review of literature. *J. Urol.*, 25: 213, 1931.
- THOMAS, B. A. Enormous solitary cyst of the kidney associated with pyonephrosis. *J. Urol.*, 18: 528, 1927.
- VONACHER, J. R. and SPRINGER, A. Solitary cyst of the kidney; report of a case. *Illinois M. J.*, 51: 413, 1927.
- WALKER, SIR. J. THOMSON. Relation of calcified abdominal glands to urinary surgery. *Proc. Roy. Soc. Med., Sect. Urol.*, 16: 45, 1923.
- WALTER, W. A Case of nephrectomy for cystic tumour of a floating kidney. *Brit. M. J.*, 2: 615, 1883.
- WASMUHT, K. Solitary cyst of the kidney; case. *Zentralbl. f. Chir.*, 67: 2259, 1940.
- WEIL, R. Concerning a distinct type of hypernephroma of the kidney which simulates various cystic conditions of that organ. *Ann. Surg.*, 66: 418, 1907.
- ZEISSLER, E. P. Cyst of the kidney. *Internat. J. Surg.*, 27: 252, 1914.

THEORY AND THERAPY OF SHOCK*

REDUCED TEMPERATURES IN SHOCK TREATMENT

FREDERICK M. ALLEN, M.D.

NEW YORK, NEW YORK

CLARITY may be gained by abandoning the former term of "primary" shock and replacing it with syncope, vasomotor collapse or any other expression that can be accurately defined. The single word, shock, will be used here to denote the condition formerly called "secondary" shock. A slight abbreviation of Moon's latest definition may suffice: *Shock is a disturbance of fluid balance resulting in a peripheral circulatory deficiency manifested by reduced volume and flow and increased concentration of the blood, with anoxia.*

My former publication (January 1939) devoted space to the hypothesis that the inflammation from a local injury is equivalent to shock, when it merely becomes large enough to cause systemic symptoms. That manuscript was submitted before I was aware of Moon's 1938 book, which felicitously compressed this same idea into an aphorism: "The wheal is shock in miniature."

Suboxidation and increased capillary permeability (locally or systematically) dominate the picture of shock from beginning to end, and lead to death by anoxia. The process which draws water and electrolytes into the tissue spaces from the blood and possibly also from the cells may be attributed to three possible causes, namely, an increased avidity of the tissues, a vital alteration in the capillary endothelium, or a shift of osmotic balance due to metabolic products either of the original injury or of suboxidation. Though these are probably different aspects of the same process, the point of view may have practical consequences as explained later.

The present work consists of several

hundred experiments on rats, dogs and a few cats. Though each experiment generally required about thirty hours of continuous observation, the limitations of space permit only brief summaries of most of the findings. By trials in many directions it was attempted to find methods which could be easily duplicated to yield constant invariable results, not mere percentage differences. As the principles and technic are important, they will be explained as fully as the results.

METHODS

Production of Shock. I have not felt in agreement with the recommendations of the National Research Council that present research be limited to hemorrhage, burns and mechanical trauma, as the forms of shock typically encountered in battle. If it be granted that slow or intermittent hemorrhage leads to final shock, several authors (Moon, Wiggers) nevertheless affirm that hemorrhage cannot be dependably standardized; also the hemorrhage itself is an independent disturbance and complication of capital importance which has been the subject of well known disputes. Ashworth and Kregel's finding of a different partition of intra- and extracellular water and electrolytes in hemorrhage and traumatic shock appears as a fundamental distinction. Burns cannot be exactly standardized. Also, notwithstanding improved apparatus (Duncan and Blalock) it seems probable that owing to the different conformation of different animals' legs, the standardization of muscle trauma is not very precise.^{9,13,15,16} Furthermore, therapeutic experiments aiming at survival for more than two days are

* From the Department of Physiology and Biochemistry, New York Medical College. Aided by a grant from the Committee on Scientific Research of the American Medical Association.

hampered by the prostration of hemorrhage, the uncertainties introduced by masses of burned or necrotic tissue and the liability to infection. It, therefore, seems more instructive to attempt study of an ideal "pure" shock. Noble and Collip have sought this ideal by tumbling animals in a wheel, and they justly emphasize the advantages of freedom from hemorrhage, anesthesia and infection. They disregard the possibility of maximal psychic and nervous accompaniments of the mild physical trauma.

The method of placing tourniquets on limbs was devised for my former research and continued in the present one because it involves nothing from beginning to end except the recognized shock processes of reduced oxidation and increased vascular permeability. Nervous factors are excluded by the total paralysis of nerves. There is inflammatory edema, sometimes greater than with mechanical trauma, to suit the upholders of the physical theory, and asphyxial metabolic products to suit the upholders of the toxic theory of shock. Recovery can be complete without infection or the death of a single tissue cell. The standardization is most accurate and elastic, because it can be regulated by two variables, namely, the mass of tissue ligated and the duration of ligation. The briefest possible ligation of the largest possible mass creates the least chance of hemorrhage, while at the opposite extreme legs ligated for nine or ten hours are subject to bleeding which discolors the local tissues and may influence subsequent blood counts. This escape of blood, however, is a recognized feature of the vascular changes in the severest inflammation, and is thus different from the gross rupture of vessels by trauma.

The reports of Noble and Collip and of Blalock, that the results of ligation were unreliable, may be explained as errors of novices with the method, due usually to irregular placement or later slipping of the tourniquet, wrong anesthesia, incomplete stasis due to looseness, or thrombosis due

to undue tightness of the tourniquet. Statistics of a large number of animals, perhaps just received in variable states of feeding or fasting, turned over to technicians or assistants for mass trials, without later checking by examination or autopsy to learn the reasons for failure, are less reliable than a smaller series in which the preliminary condition of every dog is known and every detail is personally carried out and watched.

Mylon, Winternitz and associates have given instructions for efficient constriction with rubber tubing, which doubtless most workers will use. From force of habit and partly with a notion of their adjustability and freedom from slipping, I have continued to make tourniquets of stationers' rubber bands looped together to form the necessary length, with a string at each end for tying. The animal is placed with the groin particularly in view; the thumb of the left hand guides the successive superimposed turns of the rubber in this area which is important in relation to thrombosis, while the fingers on the lateral surface pull the skin down as far as possible so as to include a maximum tissue mass and form a slight pad to hinder slipping. Until we can obtain the desired apparatus for narrow constriction with a measured air pressure, the tension of the tourniquet must be governed by experience. The chief danger is thrombosis, which tends to prevent shock and cause later gangrene. This danger varies with the size of the animal and its blood vessels. Care is needed to prevent its occurrence sometimes with five-hour ligations of rats' legs; it should never occur with five-hour ligations in dogs or cats; with nine-hour ligations it is mostly avoidable but may occur infrequently. Dogs and cats are left untrammelled under anesthesia, but rats are confined in individual cages narrow enough to prevent turning and meddling.

Wiggers' assertion that "efforts to devise a standard procedure that unfailingly produces shock seem as hopeless today as in 1903" was unjustified in 1942. Each

investigator can adjust standards as exactly as desired according to his strain of animals or experimental conditions, but the following rules will hold approximately.

For strong normal rats, a four-hour ligation of one hind leg is never fatal. A five-hour ligation is always fatal, unless the animal is particularly strong or has food or water during or shortly before the experiment. Average rats survive the five-hour ligation if they are given a subcutaneous or intraperitoneal injection of physiological saline early enough. More severe and fatal shock results from ligation of both hind legs for four hours. When a rat is held head downward to allow the viscera to fall toward the diaphragm, a low abdominal tourniquet makes fatal shock if applied for one and one-half to two hours. When this ligation is for one and one-half hours or slightly less, all male rats, which survive the shock, die later from urinary retention and hydronephrosis, but females can recover. The paralysis in all cases passes off within a few weeks.

Average dogs and cats withstand ligation of one hind leg for five or six hours and of both hind legs for about four hours. Ligation of both hind legs for five hours is fatal (with one exception in this series, perhaps a fault in technic). Ligation of one hind leg for nine hours is fatal. The survival period has not been standardized in a sufficient number of untreated animals, but with different degrees of severity it can be made to range from two to eight hours or longer.

The shock thus produced has been compared when necessary with the complicated forms of shock resulting from muscle trauma, burns or hemorrhage. Theoretically, however, the simplest form of standardized shock might be obtained by dehydration. The familiar injections of hypertonic sodium chloride solution are painful and the intense inflammation may be hemorrhagic; also the body is flooded with the electrolyte. In 1913 for a different purpose I described injections of dextrin, and suitable subcutaneous or intraperitoneal doses of this or some other hydro-

philic colloid may furnish an accurately standardized shock without nervous factors, anesthesia, hemorrhage or unknown toxins.

Anesthesia. At different times three plans have been followed in rats: (1) It is feasible to ligate limbs without anesthesia, because the tourniquet sinks easily into the soft tissues and rapidly paralyzes the nerves. (2) Relaxation of muscles is more convenient, and at one time the rats were momentarily etherized for the ligation. (3) Recently nembutal intraperitoneally has proved most convenient, but as the tourniquet is in position for several hours the anesthesia ends long before that time, and prior to release of the limb the rat is lively and apparently comfortable.

As rats seem to suffer less tourniquet pain than human subjects, dogs and cats seem to suffer even more, presumably because of their firm unyielding muscles. Therefore, full surgical anesthesia is indispensable, and in the present series this has been obtained with nembutal intraperitoneally, reinforced with morphine subcutaneously in refractory animals if necessary. The effect seldom lasts throughout the ligation period. Toward the end of this period the nerves are paralyzed and placid dogs are awake and seemingly comfortable, needing no anesthetic. The crying of excitable dogs is probably psychic, and is quieted with a fractional dose (one-third or one-fourth of the original dose) as correctly recommended by the Mylon-Winternitz group. The removal of the tourniquets ends all distress and the animals are free from drug effects before the onset of any severe shock.

Shock production being essentially the same with all the variations mentioned in rats and dogs, anesthesia may safely be dismissed as a significant disturbing factor.

Hemoconcentration during ligation, as mentioned also by the Mylon-Winternitz group, may amount to a rise of a million or even two million red cells, or may be absent. Possible causes are: (1) shock from the tourniquet itself; (2) the anesthetic;

(3) dehydration, rats being more susceptible than dogs; (4) more or less swelling of legs even when the tourniquet seems tight, perhaps due to blood vessels protected by bone, one leg often being swollen while the other is not. Tentatively, a plan of giving each dog 200 cc. of water by stomach tube at the beginning of ligation seemed to prevent this rise in the blood counts, but the trials were too few for certainty. These initial variations have been without apparent significance for the observations made during the later stages of shock.

Morphine subcutaneously or nembutal intraperitoneally have also proved satisfactory in fractional doses during these later stages, even when absorption of salt solution is inhibited or ascites present. Therefore, intravenous dosage has not appeared necessary.

Other Methods. Local refrigeration was accomplished as usual by immersing the animals' legs in ice water. There is no difficulty in thus chilling the legs of dogs and cats while keeping the bodies warm and dry, in a warm room, with warm coverings or if necessary with the addition of hot water bottles. The small size and incorrigible struggling of rats prevented any such success. There were harmful effects from either continuous anesthesia, or immobilization in a plaster cast, or the wetting and chilling of the body when the restraint was less secure.

Hemoconcentration was judged by erythrocyte counts. These involve a slight difference from hematocrit readings because of the evident changes in corpuscle size under some conditions. Otherwise only primitive clinical observations were made, with the addition of certain special laboratory examinations for which thanks are expressed to the co-operators. The main work was restricted essentially to survival experiments, and tedious repetition will be the only means of obtaining needed data which could have been easily available if facilities had existed at the time. The limitation during many years to experiments such

as could be carried out from the first preparation to the final clean-up strictly single-handed has irretrievably ruined far-reaching plans; but it at least provides a personal grasp of details and a demonstration that some simple results can be obtained under conditions that were calculated to make research impossible.

My former work suggested two possible approaches to shock treatment. One was refrigeration, and the original intention was to confine the present investigation to this method. The other approach was later included, however, and will form the subject of a second paper.

EXPERIMENTS

Until the kindness of Dr. O. M. Cope opened the opportunity of working in volunteer status in his laboratory, I lacked facilities for continuing my earlier experiments and it was, therefore, natural that the problem should be taken up by others. Blalock has agreed that chilling of the injured part tends to prevent shock, and in the treatment of existing shock reduced temperature prolonged life, both in his own experiments with local chilling of traumatized limbs and in his experiments with Mason on reduction of general body temperature in shock produced by either hemorrhage or muscle trauma. These obviously accurate and valuable findings may still be subject to clarification in the following respects:

1. Surgeons will agree that shock which kills in about six hours is severe. It is not a mild or border-line condition. Therefore, a lengthening of life may have been the utmost that could be expected of such treatment. The differences were not trivial. In the series with local temperature changes, the heated animals lived for an average of five hours forty-nine minutes and the chilled ones for an average of eleven hours twenty-four minutes. With full appreciation of a desire for clinical conservatism, it must be noticed that from a strictly scientific standpoint the conclu-

sions against refrigeration in both these papers are opposite to the findings.*

2. In the alterations of body temperature, Blalock and Mason mentioned that the reductions were sometimes so great as to be inapplicable clinically. Temple Fay has shown that death can occur from excessive lowering of temperature and from smaller reductions improperly produced. There is lack of a control series to show whether Blalock and Mason employed hibernation technic such as would be approved by Fay and what mortality might have occurred in their hypothermic animals without shock. The lengthened survival with cold is all the more remarkable because observers in the first World War and subsequently found cold to be an important factor in inducing and aggravating shock. Blalock, in 1934, reported that the onset of shock in anesthetized dogs was not particularly affected by cold. Obscurity concerning the reasons for these differences, together with Blalock's cautious interpretation of his latest experiments, may partly explain why a reviewer such as Andrus entirely ignores temperature reduction in the prevention or treatment of shock and recommends the out-dated practice of artificial warming, and why this practice which contains possibilities of important harm is still enforced in some military services.

Elman, Cox, Lischer and Mueller found that the survival of severely burned rats was longest at an environmental temperature of 75°F., and it was markedly shortened by heating the environment to 99°F. or cooling it to 55 or 32°F. This result seems to indicate that a moderately subnormal

body temperature is most beneficial in shock resulting from burns.

During the proof reading of this paper, Wakim and Gatch published their experiments on environmental temperatures, performed by placing rats, guinea pigs, rabbits and dogs on cold or warm surfaces. To the clinician the essential knowledge is the temperature of his patient, not of the bed, and amid the variables of shock one cannot be calculated from the other. These experiments do not demonstrate the optimum body temperature because no records of body temperature were included.

In following the Wakim-Gatch technic for dogs and rats merely anesthetized for three to five hours, additional fractional doses of nembutal were found necessary occasionally in the absence of shock. The temperature of dogs is influenced in such procedures by their size, thickness of hair and other variables; but without data for guidance, short haired dogs weighing 4.5 to 5.8 kg. were used. After some hours at a room temperature of 25°C. or 77°F., their rectal temperatures ranged from 101.4 to 102.2°F. Barbiturate administration to the point of surgical anesthesia always reduces the temperature. With the abdomen merely resting on a metal tray at room temperature, the rectal temperature of the unconscious dog falls gradually to between 97 and 95°F. With the abdomen on bottles containing water at 35°C., the rectal temperatures fell to levels between 99.6 and 100.5°F. Resting similarly on bottles at 45°C., there was moderate hyperpnea with rectal temperatures up to 102 to 102.6°F.

Albino rats of 125 to 250 Gm. weight, when huddled comfortably together, had the uniform rectal temperature of 100°F. Under anesthesia, with the abdomen resting on a metal tray at room temperature of 25°C. (77°F.), the rectal temperature fell rapidly to the minimum of 90 to 88°F. Resting on wood instead of metal, the rectal temperatures fell to between 94 and 88°F., depending on the size of the rat and the depth of anesthesia. On uncovered bottles containing water at 35°C., the rectal temperatures ranged between 96.6 and 98.4°F., mostly 98°F. On uncovered bottles containing water at 45°C. the rectal temperatures rose to 103 to 104°F., with hyperpnea. But Wakim and Gatch state that their bottles were cloth covered. Repeating the experiments with this insulation, the water at 35°C. gave rectal temperatures ranging from 96 to 99°F., according to the size of the rat and

* An editorial in the *J. A. M. A.*, February 6, 1943, incorrectly attributes the idea of reduced temperature to Blalock and to Williams. Owing to the system of controlling large research funds, my original findings were limited chiefly to rats, and Blalock's authoritative confirmation in dogs has been valuable. His therapeutic pessimism, based on the usual failure of the refrigerated animals to recover ultimately, has been consistently expressed in his papers and in a lecture before the New York Academy of Medicine on January 7, 1943. My present experiments offer the first method for uniform recovery of refrigerated animals from fatally severe existing shock.

the depth of anesthesia. Water at 45°C. gave rectal temperatures from 101 to 103°F. according to the same variables, with hyperpnea. All these rectal temperatures would presumably have fallen lower if the water had been allowed to cool as described by Wakim and Gatch in the course of their rat experiments.

Thus, the fall of body temperature which is so marked with surgical anesthesia at 25° atmospheric temperature is not entirely prevented by resting the animals on water bottles at 35°C. But Wakim and Gatch furthermore produced shock by exposure of viscera and stripping of intestine. Assuming that this procedure had its usual powerful effect in reducing temperature, and that therefore the animals of Wakim and Gatch had body temperatures appreciably lower than those recorded above for merely anesthetized animals, their experiments must be interpreted as follows: Their shocked animals on ice bags died quickly because their body temperatures fell far below the limits which have been found safe in artificial hibernation. Their animals at room temperature had notably long survivals with very low body temperature. The longest survivals in all species were in the groups at 35°C., which presumably had body temperatures slightly below normal. Placing the animals on bags at 45°C. presumably raised the body temperature to a full normal level, and thus caused early death. These assumed interpretations are identical with the conclusions which I established experimentally for rats in my 1939 paper.

Wakim and Gatch have rendered valuable service in adding experimental and theoretical warnings against the prevalent practice of overheating patients in shock. Until the optimum body temperature is positively demonstrated for large species such as dog and man, there is danger that too much wrapping in blankets may be nearly as harmful as heating devices. No change has been made in the conclusions of the present paper as already written, but in this war emergency the numerous readers of the *J. A. M. A.* should not decide uncritically whether a mildly reduced body temperature in shock is a beneficial reaction or an injury requiring correction.

Still more recent notes favorable to reduced temperature in shock are those of Waters, Perry and Fay (*J. A. M. A.*, 121: 783, 966 and 1109, 1943).

3. As Blalock's results were considered inconclusive by himself, they could have been carried farther in three ways: (1) A milder and more precisely standardized form of shock might be used to decide whether reduced temperature can actually save life. (2) As I formerly showed that refrigerated limbs can be segregated by a tourniquet for long periods without harm or shock, intermittent ligations of this kind might be used to allow time for systemic recovery. (3) Adjuvant treatment might be employed. An important advantage of Blalock's undercooled animals was that they were alive long after the controls were dead. Temperature reduction may render a sufficient service if it can keep wounded men alive or postpone the severest stage of shock until other treatment is obtainable.

LOCAL CHILLING WITHOUT TOURNIQUET

In order to gain preliminary information with less expensive animals, many time-consuming attempts were made with rats, resulting in complete failure. The harmfulness of cold was illustrated when the animals were wet and shivering, with reduced rectal temperatures. Struggling was also conducive to shock by reason of exhaustion, and too much anesthesia was detrimental. For these reasons the rats with their hind legs in ice water sometimes died sooner than the controls, and results were hopelessly mixed because of the failure to develop a satisfactory method for such small animals.

There was no difficulty with dogs (and a few cats) which had been routinely subjected to ligation of both hind legs for five hours. The legs were then immediately immersed in ice water and constant supervision maintained for twenty-four to thirty-eight hours, usually thirty hours. Rectal and esophageal temperatures were taken frequently, the former being often several degrees lower than the latter even with the thermometer inserted several inches. Red cell counts were taken from ear veins every two or three hours. The dogs were tied as lightly as possible. If obstreperous, they

could be kept quiet with minimal doses of nembutal without affecting the experiment. Their position was changed occasionally for comfort, and every five or six hours they were rested by being given liberty on the floor for a few minutes. Such experiments are so simple that only the results need be summarized.

In all instances the lengthened survival reported by Blalock was confirmed. The differences were not small, for while the untreated dogs died in three to seven hours, no treated animal survived less than fourteen hours; some lived twenty-two to twenty-eight hours, and two were returned to their cages in supposedly fair condition after thirty hours but died when unwatched during the ensuing twelve hours. Also it was not a mere prolongation of a half-dead hopeless state, because often the treated dogs could still wag their tails cheerfully when the controls were dead. Nevertheless, the ultimate outcome was fatal, as Blalock described. Without the labor of dissecting and weighing legs, it was obvious from examination both during life and at autopsy that the local swelling was delayed rather than prevented. As the edema accumulated the red cell counts rose and the symptoms increased, until death occurred under essentially the same conditions as in the untreated animals, only later.

Instead of an accumulation of statistical figures under a single fixed plan, the work consisted mainly of a variety of orientation experiments, scarcely any two groups exactly alike, with milder degrees of shock, more efficient refrigeration or simple adjuvant treatments, in the attempt to demonstrate a positive saving of life. The possibility is not excluded that with the right degree of shock and with better methods, perhaps also extended over a longer time, this result might be obtained. It can only be recorded that these numerous trials did not disclose any plan whereby animals would positively die if untreated and would positively recover under treatment by refrigeration alone.

This failure was found to be retrieved by fluid administration in the form of water liberally by stomach, or water and milk alternately, or subcutaneous injection of 200 to 500 cc. of physiological saline. It did not seem a fair experiment to let these animals die by dehydration or for lack of enough fluid to provide for their leg edema. Trials of several variations of this plan showed that dogs with positively fatal shock produced by ligation of both hind legs for five hours could definitely recover, that their symptoms were mild and their red cell counts increased by no more than two million, if the fluid administration was begun soon after removal of the tourniquets and the legs were chilled for thirty hours. Control animals collapsed too rapidly to get the benefit of the fluid, which was lost by vomiting or diarrhea or found at autopsy in the stomach or under the skin.

The effectiveness of this method was found to be limited, because it was unable to save dogs which had both hind legs ligated for seven or nine hours; also, after the five-hour ligations, if there was a delay of one to two hours between the removal of the tourniquets and the beginning of treatment, the survival was only lengthened and was not permanent. Other trials showed that when the fluid administration was intensified the refrigeration period could be shortened, and vice versa. Other gradations appeared when it was found that with barely fatal degrees of shock, some dogs could be saved by prompt intensive fluid administration without refrigeration. Two questions then became prominent: First, within what limits of severity or duration of shock can local refrigeration be demonstrated as life-saving in comparison with normal temperature controls? Second, as the human leg is so much thicker than that of the dog, and the living tissue is such a powerful thermal insulator unless its blood supply is seriously reduced, also as treatment in human shock cases can seldom be immediate, are the results in dogs sufficient in magnitude to promise substantial benefits in patients?

At about this stage it was learned that experiments along this line were being well and successfully conducted in another laboratory. This labor was, therefore, relinquished in favor of those who were equipped to make more rapid progress and to gather more comprehensive data. Only an extensive preliminary exploration having been made, only one positive conclusion is drawn from this phase of the work, namely that dogs with certain degrees of fatal shock due to asphyxia of the hind legs can be saved permanently by suitable chilling of the legs together with administration of fluid by stomach or subcutaneously.

The clinical application could have advanced more rapidly except for the scarcity of suitable cases in the City Hospital. Dr. Lyman Weeks Crossman hopes to make a report on the use in compound fractures and other conditions of shock and infection in the limbs. This method also has the advantage of applicability to superficial lesions in other parts of the body, which means preeminently burns, also frost-bite. As burns make up an important part of war casualties and the cold does not interfere with accepted methods of treatment, it has been unfortunate that this clinical study could not be pushed more rapidly. It can be stated at least that the few observations to date give definite encouragement as regards the influence on pain, shock, vesication and infection.*

LOCAL REFRIGERATION WITH TOURNIQUET

This part of the work had been conducted simultaneously with the preceding, and was carried a little farther because it seemed unlikely to be duplicated elsewhere. With the tourniquet the term refrigeration is better justified because the limb, either animal or human, can be chilled through-and-through to minimal temperatures which are never obtainable without the tourniquet or some other severe obstruction to the circulation. This method also stops hemorrhage.¹³

This treatment is conformable with either of the two theories of shock. Under one theory, there is cessation of absorption of a toxin and of its further formation. Under the other theory the outpouring of local edema is checked. Two procedures are possible and were tried. One is to imitate the plan formerly used in strychnine experiments, namely, to remove the tourniquet only very briefly at long intervals at first, then gradually to lengthen the free periods and shorten the ligation periods, until after long treatment the body will have disposed of the otherwise fatal quantity of poison. Under this plan the tourniquet is replaced in the same or nearly the same location each time, and the explanation can be conceived equally well as a delay of edema formation which allows time for the circulation to compensate. The other plan is to remove the tourniquet at various intervals and to replace it a little lower each time. The amount of tissue subject to either toxin production or edema formation is thus reduced gradually to the vanishing point; also the danger of vascular damage and thrombosis is supposedly lessened by placing the tourniquet always at different levels. Trials were made of a wide range of tourniquet application and release, and a combination of the two plans was finally adopted; namely, the tourniquet was removed for very short periods at first and later for gradually lengthened periods, and it was replaced each time about 1 cm. below the former level. The first "short" release of the tourniquet ranged in different trials from two minutes to fifteen minutes, and this was lengthened gradually to thirty minutes after twenty-four hours. The dogs were given freedom on the floor during part of these free periods. The periods of continuous ligation and refrigeration ranged in different trials from one hour to six hours, and were gradually shortened toward the close of treatment. The temperature readings, blood counts and other observations were made in the same way as in the experiments without tourniquet.

* Allen, Crossman, Safford. Reduced temperature treatment for burns and frost-bite. To be published.

Rats bore refrigeration better with the tourniquet than without, the chilling of the body being naturally much less. With shock produced by ligation of one hind leg for five or six hours or of both hind legs for four hours it was frequently possible to save life, but this success was entirely illusory. With the soft tissues and small blood vessels of the rat, thrombosis always occurred; and as it was absent in the controls, it evidently resulted from repeated ligations of a badly asphyxiated leg in spite of refrigeration. It was not prevented by replacing the tourniquet always at a new level. Although gangrene of one entire hind leg is fatal in the larger species, about half the rats were able to survive, but such recovery has no significance for the problem of shock.

In dogs, the discrepancy between rectal and esophageal temperatures was less than without the tourniquet, and often the two were practically equal. In spite of the evident paralysis of nerves, there were some complaints over the repeated ligations when they were high up, but the requirements for sedation were very small. The influence on shock was evidently more powerful than without the tourniquet, but it was a disappointment that no such animals were permanently saved by refrigeration alone, even when the treatment was extended as long as thirty-eight hours. These dogs could remain remarkably lively after the untreated controls were dead, but the typical blood changes and fatal outcome were only delayed. Several dogs retained exceptionally normal blood counts and general condition and seemed to recover brilliantly, but in each instance the apparent success proved to be due to thrombosis, followed by gangrene and death within a few days.

Although the results were poorest when tourniquets were removed for long periods at the beginning of treatment, the legs swelled to an unexpected degree even when the free intervals were very short. The swelling even seemed to increase while the tourniquets were in place. The apparently

tight tourniquets may have failed to block circulation totally because of the firmness of the chilled tissues, or it may be possible to think of the unknown rate of simple diffusion through cold tissues and other uncertainties. The advance of hemoconcentration and fatal symptoms in parallel with the large edema formation in the legs seems favorable to the physical theory of local fluid shift. On the other hand, various experiences leave the impression that when a moderately advanced stage of shock is reached, amputation no longer saves life, even if shock and fluid accumulation in the stump are prevented by refrigeration, so that the continued rise in cell counts after such an amputation may need to be explained in chemical terms, namely, as a general capillary change due either to a primary toxin or to anoxia.

With the tourniquet, dogs were enabled to make even better use of water or milk by stomach tube or subcutaneous saline injections than without the tourniquet, and survival was favored accordingly. The blood counts were kept within safe limits and permanent recovery was obtained not only after five hours of ligation of both hind legs, but also in trials of seven hours and nine hours of ligation, representing a severity of shock which had proved incurable without the tourniquet. It was not possible thus to cure a dog which had been subjected to a nine-hour ligation of both hind legs, with a delay of one hour between the removal of the tourniquet and the beginning of treatment.

Again, the provision of fluid to relieve dehydration and compensate for local edema formation seemed reasonable and fair as an experimental plan. In clinical application, there is the certainty that human limbs can be thoroughly chilled with the aid of a tourniquet, and if the refrigeration can retard shock for many hours during which the patient remains able to profit by adjuvant treatment, the benefit will be genuine.

An important obstacle to this use of the tourniquet must be given full emphasis,

namely, the frequency of thrombosis. The incidence is erratic; for example, not a single dog developed thrombosis in both hind legs, but there was a high percentage in one hind leg even after the five-hour ligations, when there is practically no thrombosis in the controls or after refrigeration alone; and after seven-hour or nine-hour ligations this complication was very difficult to avoid. The fact that my former demonstration of fifty-four hours of ligation-refrigeration of normal animals' legs without thrombosis does not hold good for damaged legs should not add unduly to the prevalent prejudices against tourniquets. It is readily shown in experiments that wounds, or the nutritive damage resulting from long asphyxia at room temperature, furnish starting points for thrombosis which can then spread disastrously in spite of refrigeration. This danger is inversely proportional to size; it is greatest in rats, less in cats, still less in dogs, and apparently least in man. On Dr. L. W. Crossman's service at City Hospital, trials of six or eight hours' refrigeration-ligation of ulcerated or infected arteriosclerotic legs have proved harmless. Dr. Crossman received a report from another hospital where the traumatized arm of a young man was kept packed in ice with a tourniquet for forty-eight hours continuously, and after amputation the part of the stump distal to the tourniquet had good vitality and healed well. For this and other reasons it is unfortunate that there has been no co-operation with a view to the value or limitations of the method for military use. On the existing evidence it is only possible to suggest the following rules, which are conservative perhaps to an unnecessary degree:

(1) A tourniquet should not be used without a positive indication or a planned purpose. One example is a permanent tourniquet to be left in position until after a hopelessly mangled limb has been amputated, as advised in the former World War.

(2) The only indication for a temporary tourniquet at ordinary temperature is un-

controllable hemorrhage. The limb should then be kept at the lowest temperature that is feasible without freezing. At certain intervals the circulation should be restored either momentarily or for a time governed by the effectiveness of local pressure for controlling bleeding. The time limit of continuous tourniquet application should be half an hour in summer weather and longer in proportion as the temperature is lower.

(3) If refrigeration is available, it is a safe aid for inhibiting some degrees of shock, more or less superficial infections, etc., without a tourniquet. Temple Fay has emphasized the value for gas-forming infections.

(4) A tourniquet may be used with refrigeration for controlling hemorrhage, or more severe shock, infection or pain, or for anesthesia preparatory to operation. The safe time of application to a wounded limb is at least three or four hours and probably much longer, depending partly on the character of the wound.

(5) For extreme emergencies of shock or wounds which might require ligation-refrigeration for ten to twenty-four hours or longer, the use of heparin may assure safety, because the animal experiments indicate that there is no danger except thrombosis.

(6) If the shock or other emergency is serious enough to threaten life, the tourniquet and refrigeration can be used for the longest times without heparin. There is a fair chance of absence of harm; but if thrombosis occurs, an amputation can be performed without other anesthesia and life can be saved at the cost of the limb.

GENERAL HYPOTHERMIA

Local reduction of temperature can be very radical in degree, but its range of application is confined practically to the limbs or superficial areas. Reduction of general body temperature has the advantage of being applicable to shock from any source, but physiologically it is very different because the safe degree of cooling is so slight in comparison with limb refrigera-

tion. Besides the lengthened survival in the previously mentioned experiments of Blalock and Mason, the possible benefit of hypothermia in shock is suggested by the following considerations:

(1) Temple Fay, the originator of this general principle, is convinced of the value for shock in his clinical experience. It is not clear whether his observations pertained to nervous injuries or the hemoconcentration type of shock.

(2) There is full agreement of authorities that death from shock is due not to toxemia but to anoxemia. Fatal tissue anoxia results from the diminution of both volume flow and oxygen content of the blood. Total metabolism is reduced because the cells cannot obtain enough oxygen for their vital activities; it is an internal suffocation. When there is struggling, shivering and increased vascular contraction from cold, it is easy to understand how bodily reserves are used up and the demand for oxygen increased, and the traditional influence of cold in aggravating shock is thus explained. But the patient with obtunded sensibilities in deep shock does not react to cold with shivering, and the reduced metabolic activity in artificial hibernation entails less oxygen consumption. The brighter, red color of the blood was noticed by Blalock (1934). This reduction of the oxygen need to compensate for a deficient supply corresponds to the principle employed in local refrigeration.

(3) In my previous investigation it was noticed that the labile temperature of rats is subject to marked spontaneous reduction during shock. The shocked rats will not huddle together for warmth; they resist every kind of attempt to warm them; they live far longer at moderately low temperature and die quickly if they are artificially warmed to normal temperature. The exquisitely efficient instincts and defense reactions of the rat, here illustrated, are in accord with the theoretical explanation in the preceding paragraph.

(4) Chambers and his co-workers discovered that rats placed in an icebox sur-

vived hemorrhages which were fatal at room temperature. Theoretically, the cold might favor contraction of blood vessels, and if the rats were torpid at reduced body temperature their metabolic needs would be reduced. While hypothermia thus apparently prevents hemorrhagic shock, there seems to be reason to doubt that it could save rats which were allowed to go into shock before the treatment was begun. Strictly, therefore, the contribution suggests cold as a new aid in the management of acute hemorrhage and probably of shock combined with fresh hemorrhage.

(5) Blalock, in 1934, noticed that chilled dogs were extremely sensitive to pentobarbital, less so to morphine. Barrows and Dodds recently have suggested from observations on mice that reduced body temperature may be a means of reducing the dose and lengthening the effect of anesthetics. Fay's discovery of the relief of pain by cryotherapy, likewise Parker's recent experiments, may find application when pain is present with shock.

In beginning the present experiments, it was deemed desirable to develop a technic by using normal cats as controls. Contrary to accepted ideas, morphine is the best sedative for this purpose in cats as well as dogs. The initial excitation which has disturbed cats and physiologists is obviated by a preliminary injection of nembutal, after which the animals can be kept asleep with repeated minimal doses of morphine for several days if desired. The body temperature is then easily reduced with ice bags, and later a dormant hypothermic state is maintained with very little use of cold or drugs, this being the artificial hibernation discovered by Fay. The continuity is such that finally when left in a room of average warmth the animals may require twelve to twenty-four hours to regain their normal temperature and activity. Care must be taken to prevent the hypothermia from becoming too extreme. Rectal temperatures of about 90°F. are conservative for workers who lack Fay's skill. Not only is too severe or too prolonged hypothermia

fatal, but it must be remembered that methods which tax the strength of normal animals cannot be a suitable treatment for a badly weakened state of shock. Reductions of the rectal temperature to about 90°F. were selected as suiting the needs in shock, and were well tolerated by normal cats. Nevertheless, a series of such hibernations with one or two days of rest between are fatal to cats, which are not seriously weakened by the same duration of simple fasting. This seems to confirm the opinion of most observers that cryotherapy is a strain upon the bodily strength. The greater stamina of human beings as compared with cats or even dogs may partly explain Fay's accomplishments in the degree and duration of temperature reduction in patients, but deficiencies in my own technic must also be considered.

Preliminary observations with various degrees of shock produced by leg ligations in cats showed that death might be hastened when the body temperatures accidentally fell to 80°F. or lower, and within conservative limits of about 90°F. the prolongation of life was not striking and positive as in rats. The supply of cats was temporarily cut off by cold weather, but the results up to this point seemed disappointing as regards any permanent preservation of life by hypothermia, even with the lightest degrees of shock that could be counted on as fatal for controls.

Further opportunities were furnished by the experiments with local refrigeration in dogs. When these animals are completely or partially awake, they maintain approximately normal body temperatures with very little aid; but if they are kept asleep with small cautious doses of nembutal or morphine, the chilling effect of the hind legs in ice water must be counterbalanced usually by warming of the body. Here again, excessively low body temperatures continuing for several hours result fatally in spite of subsequent warming. In several trials when the body temperature was held at selected levels from 90°F. up to normal, no benefit was perceptible. Rather, an

approximately normal temperature seemed to be accompanied by a slightly better preservation of strength, so that in actual practice normal body temperatures were preferred in these experiments. The chilling of the hind legs, which were the source of shock, may perhaps have accomplished all that was possible with cold. The slight impairment of strength may perhaps be blamed upon the deeper anesthesia. The main point seemed to be that the hypothermia did not exhibit any countervailing benefits.

In subsequent experiments with fluid injections, a comparison was made between two closely matched dogs, which were shocked by five-hour ligations of both hind legs and afterward treated identically, except that the body temperature was allowed to remain normal in one, and in the other it was kept at approximately 90°F. by ice bags applied to the foreparts with strict avoidance of the hind legs. The same small intraperitoneal injections of nembutal were given to both, though the hypothermic dog was thus kept asleep while the normothermic one was only drowsy. Both animals survived, with only a slightly noticeable inferiority of strength in the hypothermic one. This dog refused to eat and three days later was unexpectedly found dead, with a small amount of thick pus in the peritoneum at autopsy. This was the only instance in the entire series of chilled or nonchilled animals in which nembutal injections led to infection, but it may suggest some degree of lowering of resistance by moderate reduction of body temperature.

It is conceivable that hypothermia has the double effect of retarding both the course of shock and the recovery process, on account of depressed function of the liver or other sensitive viscera. The pressure of other phases of the research together with the duties of medical practice necessitated dropping the problem at this point, but it would be misleading to leave the impression of a definitive failure of hypothermia. The planned continuance of the

work would have followed up the beginning made by Blalock and Mason. Accepting their finding that a point is reached in shock when the hypothermic animals are alive and the controls kept at normal temperature are dead, the possibility is open that the living animals may be capable of permanent recovery with the aid of other treatment. This suggestion corresponds to the experience with local refrigeration, and it may reconcile and harmonize all the seemingly conflicting evidence. Temple Fay's position need imply nothing more than that the course of shock is retarded, exactly as Blalock and Mason found, and that the patient is thus enabled to recuperate with the aid of medical and nursing care.

This interpretation, together with the observation of Chambers, suggests that in emergencies of shock and hemorrhage at least the temporary survival of the patient until he can obtain further treatment is favored by lower rather than higher temperatures. There are obvious common sense reasons why extreme exposure calls for treatment by reasonable warming. Also extremes in treatment should be avoided by practitioners until the uncertainties have been settled by experts. There is already good reason, however, for believing that a slightly subnormal temperature in a shocked or bleeding patient is a harmless and beneficial reaction. The coverings should not be excessively warm, and in particular artificial heating is injurious theoretically and according to the unanimous experimental results.

CONCLUSIONS

1. The method of producing shock by asphyxia of limbs has been described, especially with reference to accuracy of standardization, freedom from complications and suitability for therapeutic experiments with recovery.

2. Local refrigeration, which was formerly found effective for preventing shock, is also helpful in the treatment of shock originating from the limbs and presumably

other bodily areas which can be efficiently chilled. The survival of shocked dogs is lengthened by simple refrigeration of the injured legs, and still more by prolonged or intermittent tourniquet application with refrigeration.

3. The essential therapeutic effect of these measures is a retardation of the shock process, affording a greatly lengthened time for other treatment and better ability to respond to it. Within limits, the lengthened survival can be converted into permanent recovery by the simple administration of fluids by stomach or salt solution subcutaneously.

4. The simple local refrigeration is harmless. The only danger from the most prolonged tourniquet application with refrigeration is thrombosis. Certain rules were provisionally suggested for conservative clinical application of these methods for shock and complications, with a particular view to military uses at present.

5. The investigation of systemic hypothermia was left unfinished, and the conclusions are limited to a warning against the misuse of artificial heat and a suggestion of the advantage of slightly subnormal temperature. Extreme measures should be held in abeyance until they can be tested by further research.

REFERENCES

1. ALLEN, F. M. Studies concerning glycosuria and diabetes. Harvard Univ. Press, 1913. Local asphyxia and temperature changes in relation to gangrene and other surgical problems. *Tr. Ass. Am. Phys.*, 52: 189-194, 1937. Experiments concerning ligation and refrigeration in relation to local intoxication and infection. *Surg., Gynec. & Obst.*, 68: 1047-1051, 1939. Physical and toxic factors in shock. *Arch. Surg.*, 38: 155-180, 1939. Reduced temperatures in surgery. III. Experiments on pelvic and abdominal refrigeration with especial reference to traumatic and military surgery. *Am. J. Surg.*, 55: 451-466, 1942.
2. ANDRUS, W. D. Present concepts of the origin and treatment of traumatic shock. *Surg., Gynec. & Obst.*, (*Internat. Abstr. Surg.*) 75: 161-175, 1942.
3. ASHWORTH, C. T. and KREGEL, L. A. Changes in the body water partition and extracellular electrolytes in shock. *Arch. Surg.*, 14: 829-839, 1942.
4. BARROWS, E. F., and DODDS, H. Body temperature of mice during anesthesia. *Am. J. Physiol.*, 137: 259-262, 1942.

5. BLALOCK, A. Influence of exposure to cold and of deprivation of food and water on the development of shock. *Arch. Surg.*, 29: 1055-1068, 1934. Principles of Surgical Care. Shock and Other Problems. St. Louis, 1940. C. V. Mosby Co. A comparison of the effects of the local application of heat and of cold in the prevention and treatment of experimental traumatic shock. *Surgery*, 11: 356-359, 1942. (With Mason.) A comparison of the effects of heat and those of cold in the prevention and treatment of shock. *Arch. Surg.*, 42: 1054-1059, 1941. (With Duncan.) The uniform production of experimental shock by crush injury: possible relationship to clinical crush syndrome. *Ann. Surg.*, 115: 684-697, 1942.
6. CHAMBERS, R. et al. Personal communication. Publication forthcoming.
7. CROSSMAN, L. W., ALLEN, F. M., HURLEY, V., RUGGIERO, W. and WARDEN, C. E. Refrigeration anesthesia. *Anesth. & Analg.*, Sept.-Oct., 1942.
- 7a. ELMAN, R., COX, W. M., LISCHER, C. and MUELLER, A. J. *Proc. Soc. Exper. Biol. & Med.*, 51: 350-351, 1942.
8. FAY, T. Personal communication. Cf. also Smith, L. W. The use of cold in medicine. *Ann. Int. Med.*, 17: 618-636, 1942.
9. GUTMAN, H., OLSON, W. H., LEVINSON, S. O., and NECHELES, H. A study of the effects of isotonic serum and saline infusion following trauma in dogs. *Am. J. Physiol.*, 137: 355-361, 1942.
10. HARKINS, H. N. Recent advances in the study and management of traumatic shock. *Surgery*, 9: 231-294, 447-482 and 607-655, 1941.
11. MOON, V. H. Shock. Its Dynamics, Occurrence and Management. Philadelphia, 1942. Lea & Febiger.
12. MYLON, E., WINTERNITZ, M. C., KATZENSTEIN, R. and DE SÜTÖ-NAGY, G. J. Studies on mechanisms involved in shock. *Am. J. Physiol.*, 137: 280-298, 1942.
13. NOBLE, R. L. and COLLIP, J. B. A quantitative method for the production of experimental traumatic shock without haemorrhage in unanesthetized animals. *Quart. J. Exper. Physiol.*, 31: 187-199, 1942.
14. PARKER, G. H. General anesthesia by cooling. *Proc. Soc. Exp. Biol. & Med.*, 42: 186-187, 1939.
15. SCULL, C. W., and EINMAN, J. Physiologic and clinical basis for treatment of shock. *Clinics*, 1: 43-58, 1942.
16. WAKIM, K. G., and GATCH, W. D. The effect of external temperature on shock. *J. A. M. A.*, 121: 903-907, 1943.
17. WIGGERS, C. J. The present status of the shock problem. *Physiol. Rev.*, 22: 74-123, 1942. (With Werle and Cosby.) Observations on hemorrhagic hypotension and hemorrhagic shock. *Am. J. Physiol.*, 136: 401-420, 1942.



A NEW OPERATION FOR THE REPAIR OF THE CRUCIAL LIGAMENTS OF THE KNEE

FRED H. ALBEE, M.D.

Consultant Orthopedic Surgeon, Hospital for Joint Diseases

NEW YORK, NEW YORK

NO joint in the human body is liable to such a diverse legion of severe and trivial injuries as the knee joint. And of all this host of injuries, there is none that is more frequently overlooked, but in the literature and in life, than the avulsion or rupture of the crucial ligaments. Resultant abnormal movement of the tibial plateau upon the femoral condyles is very important and should always be tested for.

In all active people (especially in those athletically inclined) and those whose occupations require strenuous labor, early repair of ligamentous ruptures is urgent since excessive use of unstable knee joints usually results in damage to the semilunar cartilages and development of local osteo-arthritis that impair the results of any subsequent operation.

In this series of nine cases which have been done over a period of seven years, sufficient time has elapsed and data are now available to evaluate the procedure. The posterior ligament was ruptured in only one case. In three cases, both ligaments were gone and in one case, the result was not satisfactory because of limitation of motion. In all other cases, the results as to stability and motion were good. No patient was operated upon who did not present marked anteroposterior laxity. In one case not in this series, the anterior crucial ligament was found ruptured at primary exploratory arthrotomy through the split patellar approach. It was successfully sutured with silk and was not diagnosed preoperatively.

Clinicians have made a great point of formulating different operative procedures according to whether the posterior or

anterior crucial ligament has been involved. Yet, from a study of a good many cases, both before and after reconstruction proce-

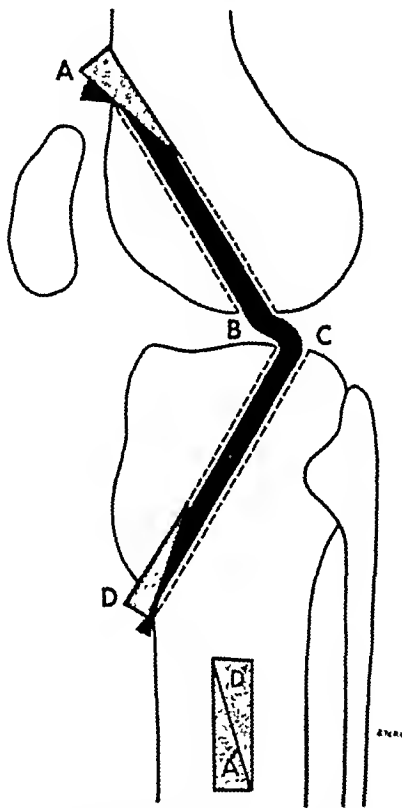


FIG. 1. This diagram discloses the general scheme of the operation. The black indicates the fascia lata extending through the drill holes into the condyles of the femur and the head of the tibia and traversing the joint at B. Extreme tension at B and C is firmly held by bone-graft keys at A and D which are obtained from the head of the tibia at A' and D'.

dures have been attempted, it is my firm conclusion that the fundamental principle of treatment should be the same whether both ligaments or only one of them has been involved. That is, the attempt should be made to hold the head of the tibia firmly anteriorly in relation to the lower

FIG. 2.

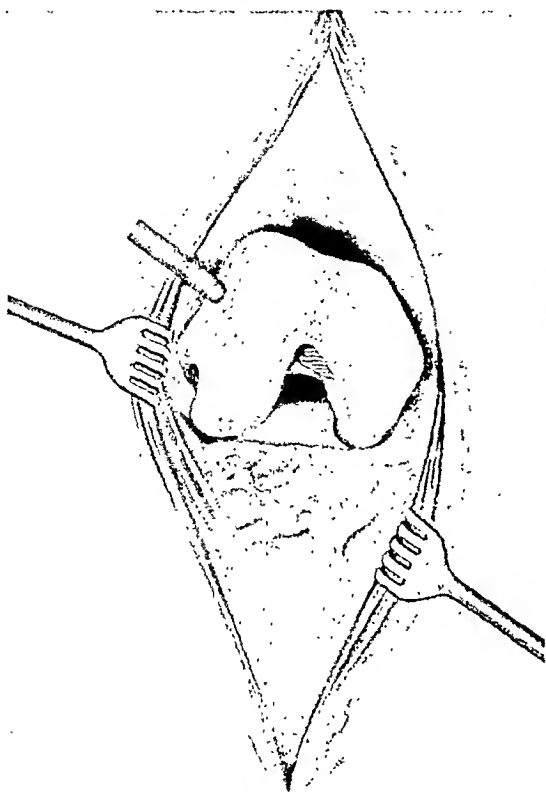


FIG. 3.

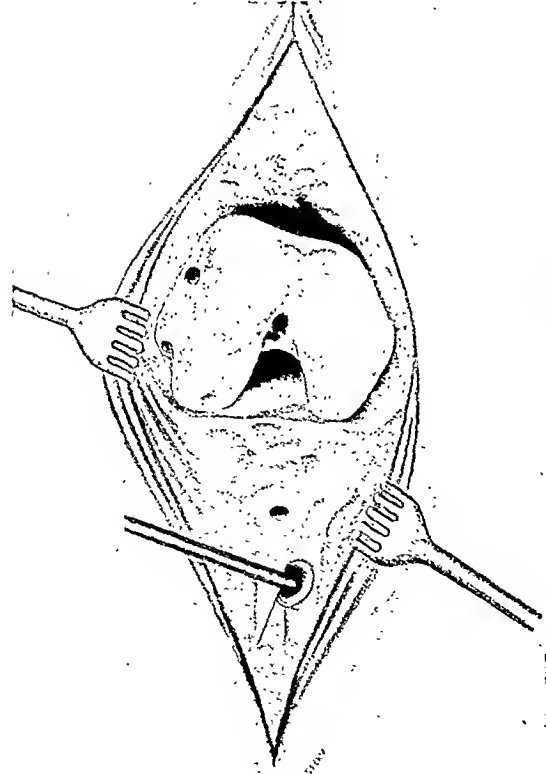
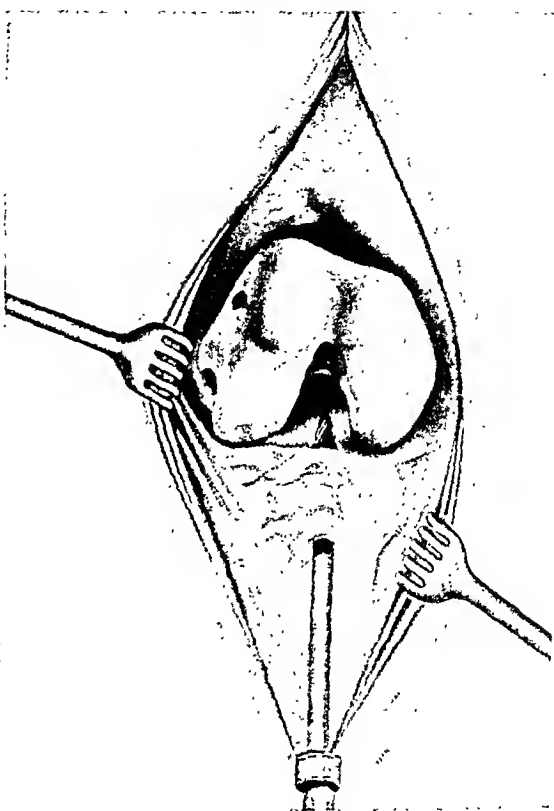


FIG. 4.

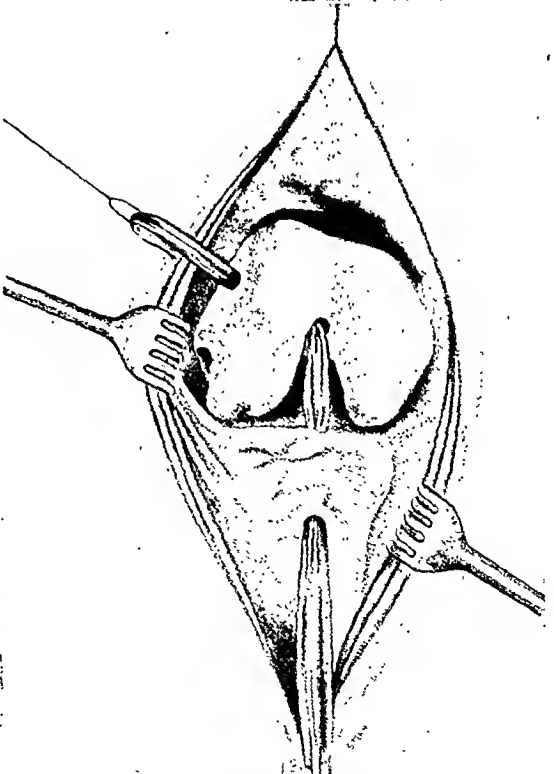


FIG. 5.

For descriptive legend see opposite page.

end of the femur in both instances, unless there is a marked laxity in the opposite direction. Therefore, in replacing the crucial ligament, the attachment of the new ligament should be relatively anterior on the lower end of the femur and posterior on the head of the tibia. It should be placed with a tension equal to that of the normal ligaments. In other words, at the time of insertion, the new ligament should have as nearly as possible the tension of a banjo string or bow string. This cannot be permanently accomplished by the anchorage of either end of the new ligament to soft tissues, periosteum, capsule, etc., and allow early removal of immobilization and both active and passive motion with weight-bearing, which is most important in order to restore complete motion and function. Rather the new ligament must have the very firmest anchorage possible, an anchorage so designed that it will also permit the greatest amount of tautness to be maintained. As to the tear of the posterior ligament or where from the tear of the anchorage ligaments between the head of the tibia and the condyles of the femur, the tendency to displacement is in the opposite direction; that is, the tibial head luxates forward, and this can be just as readily controlled as in the case of luxation in the opposite direction by merely changing the relation of the drill holes in the head of the tibia and the condyles of the femur. In other words, the hole in the tibia is placed anteriorly to that in the femur.

In formulating a new operation for the repair of the crucial ligaments, it was my desire to effect one which would produce as little traumatization to the knee itself as possible, and the dissection around the knee should be at the minimum. This is most important if complete motion and painless

function is to result. Therefore, from this standpoint, it is desired that the living material for replacement should be obtained from as great a distance from the knee joint as possible, and that structures such as tendons, etc., which have to do with normal function, should not be used for repair material unless absolutely necessary. Since the researches of Allison and Brooks upon animals and clinically have proved the permanence and dependability of detached grafts of fascia and especially fascia lata as transplants, and these findings have been confirmed by both Gallie and myself in a large number of operations of widely varying character over many years from all standpoints, fascia lata seemed in this instance to be first choice for repair material. One of the severest tests of this material when used to replace ligaments extending through joints has been that of recurrent dislocations of the shoulder in epileptics. In a number of such cases, dating back to over twenty years, fascia lata has proved in my hands its trustworthiness and permanency for such use.

My principal excuse in offering a new operation in this field is the fact that I have seen a number of failures resulting from others' technics, and it is my belief that the principal reason for these failures has been too long postoperative immobilization, that the fascia lata replacing these ligaments has not been held permanently taut enough, the laxity increasing with the passage of time. I have believed, too, that some of the undesirable results may have been due to the poor or inaccurate placement of the new ligament. One influence leading to these types of failure, I believe, has been occasioned by the erroneous assumption that it is necessary to have a fascial or tendonous

FIG. 2. This diagram shows a $\frac{3}{8}$ inch drill penetrating the condyles of the femur with its exit at the intra-condylar notch.

FIG. 3. This diagram indicates drill of the same size as mentioned in Figure 2 penetrating the plateau of the tibia markedly posteriorly.

FIG. 4. This diagram indicates the obtaining of the bone-graft key wedges (with the motor saw) from the upper end of the anterior internal surface of the tibia.

FIG. 5. This diagram indicates the fascia lata (which has been obtained from the upper portion of the thigh) in place in the drill holes in the tibia and femur.

graft pedicled in order to insure viability and permanency. This misconception has also had an unfortunate influence in bone-graft technic.

In any event, the anchorage of the replacing fascia to soft parts has a pronounced tendency to yield immediately or slowly to the severe tension which must occur, not only from pressure coming from early normal function or undue strain. The use of fascia lata left attached at the region of the head of the fibula serves no helpful purpose but actually handicaps the surgeon most materially, in that it necessitates an undue amount of dissection in the immediate neighborhood of the joint. The anchorage of the fascia to the head of the fibula is uncertain and may yield, and also it is so far away from the location of the crucial ligament that it does not serve to maintain sufficient permanent tension of the new ligament. In this respect, it should be noted, that in every previously reported operation for the repair of the crucial ligament, the fascial or tendonous material has been attached to soft parts: the head of the fibula, the periosteum, the joint capsule, or some other similar anchorage in the periphery of the joint. The fascia in the technic herein described is obtained with a minimum amount of dissection, at a distance from the knee joint and in any desired dimensions or strength required. An Esmarch's bandage and tourniquet high on the thigh is used so that a bloodless field is assured.

The joint is entered through the midline by a split patellar vertical incision which brings the surgeon with ample exposure directly to the operative field with the least amount of trauma, and removes the danger of postoperatively increasing the laxity of the capsule which results from the transverse patellar incision and does much less damage to the synovial membrane. This approach which the author has used in every case of exploratory arthrotomy for over twenty years, is less damaging and safer than the peripatellar incision. Because of the straightness of this incision, early

flexion of the knee tends to pull together both the fragments of the patella as well as the soft parts throughout their extent, whereas in the case of the tortuous peripatellar incision, the synovial membrane tends to pull away from the top and bottom of the patella from the tension produced by early knee flexion. The author has seen four cases in which this happened and sometime afterward, the knee joints were found filled with hematomas, the results of which were disastrous. By vertical split patellar approach, the damage to the crucial ligaments is plainly visible and the new ligament can be placed with greatest precision.

A drill hole, $\frac{3}{8}$ inch in diameter, (Fig. 2) is made obliquely through the outer condyle of the femur from an anterior external point to a point in the intercondylar notch which is well anterior, if it is desired in the particular case to hold the head of the tibia forward on the femoral condyles and prevent it luxating backward. If the opposite is the case and the head of the tibia luxates during function forward on the condyles, this drill hole should be placed more posteriorly. A drill hole the same size is then made through the same incision through the outer anterior portion of the tibia to a point as near the insertion of the crucial ligaments to the head of the tibia as possible, or well posteriorly if the tibial head luxates backward or anteriorly, or if it luxates forward. (Fig. 3.) The necessity of accurate determination of the amount and character of the motion of the tibial plateau upon the femoral condyles before operating cannot be too much stressed so as to place drill holes accordingly.

An incision high up on the thigh of the same side at the anterior outer aspect lays bare the fascia lata from which the graft—seven inches in length, and one to one and one-half inches in width, in the adult—is obtained. With a small flexible probe, through the eye of which is placed a silk loop, this fascia lata is then pulled through the drilled holes both in the head of the tibia and the condyles of the femur. (Fig. 5.) The leg is then straightened from its

flexed position. The fascial graft is firmly keyed into the tibial hole by means of a bonegraft wedge (Fig. 4) obtained from the anterior interior broad surfaces of the tibia at its upper end; (Figs. 1 and 5) the fascia lata at the femoral side is then held very tight by means of the pull of an assistant upon a clamp placed upon it, and a bonegraft key similar in nature to the one just set in the tibia, is driven into femoral hole holding the fascia lata firm and under severe tension. (Fig. 1.)

Immobilization in a plaster of Paris cast from the groin to the base of the toes, with the knee in five to ten degrees of flexion, follows for a period of two weeks (an improvement over the usual eight to seventeen weeks reported in the case of certain other operations) after which the knee is mobilized by physiotherapy, particular attention being directed to establishing motion and developing the quadriceps extension muscle.

The advantages of the procedure herein reported are: (1) It does not use for repair purposes tendon or any other structures which have to do with function of the limb, (2) It disturbs to the minimum the peri-articular structures other than the least possible traumatizing approach to the knee joint; there is no local dissection which has been a distinct disadvantage of previous operations. Even the repair material is obtained at a distance from the joint. (3) According to the literature, no operation has been designed which because of insecure anchorage of the living repair material to periosteum, capsule or other soft parts, allows less than six weeks of immobilization. The new ligament must maintain its tension and only bony anchorage will

assure this when weight-bearing and motion are allowed as early as two weeks after the operation. When this tension is maintained, it is found that attention to the lateral ligament is rarely necessary. The fascia is held in the grip of the bone-graft wedges so firmly that there is no danger of its loosening its tension from the moment of its insertion. One author definitely states that he has had stiff knees and failures from 120 days of postoperative immobilization.

REFERENCES

- GROVES, E. W. HEY. Operation for the repair of the crucial ligaments. *Lancet*, 2: 674, 1917.
 SMITH, S. ALWYN. The diagnosis and treatment of injuries to the crucial ligaments. *Brit. J. Surg.*, 6: 176, 1918-1919.
 GROVES, E. W. HEY. The crucial ligaments of the knee joint; their function, rupture and the operative treatment of the same. *Brit. J. Surg.*, 7: 505, 1919-1920.
 EDWARDS, A. H. Operative procedures suggested for the repair of collateral ligaments of the knee joint. *Brit. J. Surg.*, 8: 266, 1921.
 KRIDA, ARTHUR. A general utility incision for exploration of the knee joint. *J. Bone & Joint Surg.*, 7: 212, 1925.
 GALLIE, W. E. and LEMESURIER, A. B. Repair of injuries to the posterior crucial ligament of the knee joint. *Ann. Surg.*, 85: 592, 1927.
 PRIMI, I. and FERRARI, R. C. Traumatic rupture of the crucial ligaments with reconstructive treatment. *Semana méd.*, November, 1929.
 CAEIRO, J. A. Reconstruction of the crucial ligaments. *Buenos Aires, S. A.*, August, 1934.
 CAMPBELL, WILLIS C. An operation for repair of the internal and external lateral ligaments of the knee joint. *Surg., Gynec. & Obst.*, 60: 214, 1935.
 CAMPBELL, WILLIS C. Reconstruction of the anterior cruciate ligament. In press.
 CAMPBELL, WILLIS C. Repair of the ligaments of the knee. *Surg., Gynec. & Obst.*, 62: 964, 1936.
 CUBBINS, W. R., CALLAHAN, J. J. and SCUDERIO, C. S. Cruciate ligament injuries. *Surg., Gynec. & Obst.*, 64: 218, 1937.
 VALLS, JOSE. Traumatic lesions of the knee. *Diag. Med* October, 1941.



THE CONTROL OF ACUTE THROMBOPHLEBITIS WITH ULTRAVIOLET BLOOD IRRADIATION THERAPY*

GEORGE MILEY, M.D.

Clinical Professor of Pharmacology, The Hahnemann Medical College and Hospital
PHILADELPHIA, PENNSYLVANIA

THE sudden appearance of acute thrombophlebitis is one of the most unpredictable and unwelcome complications encountered in medicine. The relative inability of the various methods in vogue today to control this complication satisfactorily is well known and will not be discussed here.

In the last four years we have used the Knott technic of ultraviolet blood irradiation therapy in thirteen consecutive cases of thrombophlebitis with highly satisfactory results. Blood irradiation was found to control the classical symptoms of acute thrombophlebitis rapidly and efficiently in all thirteen cases, which included thrombophlebitis with and without fever, following delivery, operation or acute pyogenic infection.

The Knott technic of ultraviolet blood irradiation therapy has been described elsewhere.^{1,2,3} Briefly, it consists of the withdrawal and citration of a predetermined amount of the patient's blood, plus immediate reinjection of that citrated blood through a Knott Hemo-irradiator, a precision machine which automatically exposes the citrated blood to intense ultraviolet rays safely and efficiently, and returns the irradiated blood to the venous circulation of the patient.

We believe that as a result of our observation a new phenomenon, that of a rapid subsidence of the classical symptoms of thrombophlebitis following ultraviolet blood irradiation, has become apparent.

RESULTS

Tabular Presentation. The following table of results, as may be readily seen,

essentially shows the type and location of the acute thrombophlebitis in each patient, the time of disappearance of pain, tenderness, edema, and fever (when present), the number of blood irradiations per patient and the number of hospital days elapsing between the initial blood irradiation and discharge from the hospital. (Table 1.)

Analysis of Table. An analysis of the above table shows a definite uniformity of response to ultraviolet blood irradiation therapy. Pain and tenderness disappeared first as a rule; fever if present, disappeared next most rapidly, and edema was last to subside.

Cases 1, 2, 5, 9 and 13 are examples of failures of chemotherapy plus bed rest, local heat, and elevation of the extremity which responded successfully to ultraviolet blood irradiation therapy.

Cases 3, 10 and 11 failed to respond to local heat, bed rest, and elevation of extremity, until blood irradiation was applied.

Case 4 was seen after failure of local heat, bed rest, elevation of the extremity, and of four nerve blocks to alter the course of the disease; an advanced induration of the leg was present also. In all of these nine individuals, as well as in the other four who received ultraviolet blood irradiation therapy alone, pain, tenderness and fever when present disappeared within twenty-four to forty-eight hours. Edema disappeared in twelve individuals within three to fifteen days; in the thirteenth, in whom an advanced induration had appeared during fifty days of failure to respond to four nerve blocks, the patient was able to walk for the

* From the Blood Irradiation Clinic, Hahnemann Medical College and Hospital, Philadelphia, Pennsylvania.

first time, but edema and induration were still present at the time of hospital discharge, eight days after a single blood irradiation.

BRIEF ABSTRACTS OF TYPICAL CASE HISTORIES

CASE 1. No. 46943, age forty, a female, was admitted March 18, 1940, for a nephropexy which was done March 20, 1940. For the first two postoperative weeks the patient's convalescence was relatively uneventful, when on the fourteenth postoperative day she began complaining of pain in the left leg localized over the femoral area. A heat cradle was applied and the leg elevated, and within twenty-four hours the pain disappeared. She was allowed out of bed at this time and within a few hours her leg began to swell, temperature rose to 101.8°F. and her pulse to 120. Despite bed rest, hot compresses and 40 gr. of sulfanilamide the patient's temperature and pulse rate remained elevated for the next five days, then descended slowly with a daily peak temperature ranging between 99° and 100°F. At this time, April 15, 1940, a 500 cc. blood transfusion was given. On the following day the patient's temperature rose to 103.2°F., and her symptoms of pain and swelling which had subsided somewhat became greatly aggravated. Sulfapyridine was given (15 gr. every four hours) for forty-eight hours, but was tolerated badly. The patient's temperature continued for three days to be elevated with a daily peak ranging from 99° to 100.4°F. In addition occasional chills were present. Sulfapyridine was stopped April 17, 1940; blood culture taken on this day was negative, but no improvement was noted in the next forty-eight hours, and on April 19, 1940, ultraviolet blood irradiation therapy was instituted (200 cc. of patient's blood was irradiated according to the Knott technic). Within twenty-four hours the patient's temperature fell to normal; within forty-eight hours her pain had disappeared completely and on April 26, 1940, seven days later, swelling had disappeared. The patient convalesced uneventfully, and was discharged from the hospital April 30, 1940, in apparently excellent condition eleven days after a single blood irradiation.

CASE 7. No. 78263, age forty-eight, a female, was admitted to the hospital with a history of nausea, vomiting, and a spreading

infection of the right groin during the previous four to five days. The infection apparently originated from an infected varicose ulcer located along the course of the internal saphenous vein. Physical examination revealed a right-sided saphenous and femoral thrombophlebitis, with marked induration of the right ileo-inguinal lymph glands, a spreading erysipeloid lesion extending from the upper ileo-inguinal region down the inner surface of the thigh halfway to the knee. The lesion was discharging an extremely foul smelling sero-sanguineous fluid from several areas and there was a marked necrosis of adjacent skin areas. Her temperature on admission was 100.8°F., pulse 120. Wassermann and Kahn tests were negative, hemoglobin 11.7, red blood cells 3,950,000, white blood cells 5,000, polymorphonuclears 76 per cent, lymphocytes 24 per cent. The patient was extremely toxic and debilitated. At the end of forty-eight hours her temperature rose to 103.4°F., at which time August 10, 1942, ultraviolet blood irradiation was instituted (290 cc. of patient's blood being irradiated according to the Knott technic). During the first forty-eight hours the patient's toxic symptoms began to subside, the groin lesion broke down in several places, and the foul discharge became more profuse. The patient's temperature remained elevated at 102°F. On the third post-irradiation day the temperature began to drop and the drainage was markedly less. The patient's general condition had improved markedly. On August 15, 1942, the inflammatory process along the course of the saphenous and femoral veins had definitely subsided; pain, tenderness and swelling had disappeared. In the remaining few hospital days a rapid healing of the whole ileo-inguinal skin area occurred and the ileo-inguinal lymph glands, although still palpable, had lost their original induration. The patient convalesced uneventfully, and at the time of discharge on August 21, 1942, eleven days after a single blood irradiation, she was in excellent general condition, and the ileo-inguinal, femoral skin lesion had healed.

CASE 8. No. 70645, age forty-three, a male, was admitted to the hospital October 28, 1941, complaining of severe pain and extensive swelling of the left leg. Physical examination revealed deep, extensive thrombophlebitis of the left leg with marked induration of the edematous tissue which apparently had been present two weeks previous to admission, and

was secondary to a puncture wound of the foot. At the time of admission the patient's temperature, pulse and respiration were normal. Heat was applied and four therapeutic nerve blocks were given on October 30, 1941, November 13, 1941, November 30, 1941 and January 2, 1942. No relief of pain, tenderness or swelling was observed following any one of these blocks, and the patient was unable to bear weight on the thrombophlebitic limb at any time. On January 12, 1942, ultraviolet blood irradiation therapy was given (215 cc. of patient's blood being irradiated according to the Knott technic). Within twelve hours the patient stated that his pain was markedly diminished, and within twenty-four hours said that it had disappeared completely. At the end of forty-eight hours no tenderness could be observed, there was no appreciable reduction in swelling, and the patient was able to balance weight on the swollen limb. He was discharged from the hospital pain free and ambulatory on January 20, 1942, in a relatively improved condition, seven days after a single blood irradiation.

CASE 9. No. 71548, age twenty-four, a female, was admitted to the hospital February 6, 1942, and on February 8, 1942, delivered a normal infant. The first four postpartum days were uneventful, and on the fifth postpartum day an acute bilateral femoral phlebitis developed. A heat cradle and hot compresses were applied, and sulfathiazole gr. 45 initially and gr. 15 every six hours was given. After seventy-two hours of this combined therapy had failed to relieve the patient's symptoms of pain, tenderness and swelling, the sulfathiazole was stopped, and on February 16, 1942, the ninth postpartum day, ultraviolet blood irradiation therapy was administered (225 cc. of patient's blood being irradiated according to the Knott technic). Within twelve hours the patient's temperature fell to normal and the pain and tenderness disappeared. Forty-eight hours later no swelling could be observed. The patient was discharged February 21, 1942, five days after ultraviolet blood irradiation.

On returning home the patient began immediately to carry on normal, strenuous household duties, and suffered a recurrence of bilateral thrombophlebitis. She was readmitted to the hospital March 6, 1942, with a recurrence of pain and tenderness of both femoral regions, and a marked edema of both legs; her temperature had remained normal. At this time the patient also complained of dull pain in the right

lumbar region. Blood count and urinalysis taken at this time proved normal. Ultraviolet blood irradiation therapy was repeated the day of admission March 6, 1942 (225 cc.). The following day the patient's pain and tenderness seemed much less severe, although the pain in the right lumbar area persisted. The pain, tenderness and swelling subsided completely but slowly during the fourteen days subsequent to irradiation. Her convalescence during this time was uneventful. At the time of discharge March 20, 1942, her condition was apparently good. No further recurrence of phlebitis has been observed.

CASE 10. No. 76953, age forty-seven, a female, was admitted June 17, 1942, and prepared for vaginal hysterectomy. On the sixth hospital day, June 23, 1942, a supravaginal hysterectomy, bilateral salpingo-oophorectomy and Schroeder amputation of cervix were performed. On the evening of the day of operation the patient's temperature rose to 101.2°F., pulse to 116. This rise in temperature and pulse rate persisted for three days, the temperature then falling slowly to a level ranging between 99° and 100°F., and her pulse remaining at an approximate 100. On the twelfth postoperative day the patient began complaining of some tenderness of the left leg, femoral area, her temperature rose to 101.8°F., and pulse rate to 120. On the following day her temperature rose to 102°F., and pulse to 128. On the next day, with a marked increase in the pain and tenderness along the course of the femoral vessels in the left leg, plus a moderate amount of edema, a diagnosis of acute septic phlebitis was made at this time July 6, 1942, and the leg was elevated and a heat cradle applied. On the following day July 7, 1942, ultraviolet blood irradiation therapy was given (200 cc. of patient's blood being irradiated according to the Knott technic). Forty-eight hours later the patient stated that her pain was greatly diminished and tenderness over the femoral vessels of the left leg was markedly diminished. The patient's temperature, however, rose to a daily peak at a level between 100° and 101°F. for the next five days, although at the end of this period of time all signs of pain and tenderness had disappeared and edema was barely perceptible. It was believed that the large heat cradle which was being used during severe summer weather might possibly prevent normal dissipation of body heat, so this was removed. On the following day the patient's temperature

dropped to 99°F. The patient convalesced uneventfully from this point on with a morning temperature rise during the next few days to 99.6°F. She was discharged July 25, 1942,

eighteen days after a single blood irradiation, in apparently good condition and symptom free.

CASE 12. No. 75417, age eighteen, a female, was admitted June 24, 1942, complaining of

TABLE OF RESULTS OF ULTRAVIOLET BLOOD IRRADIATION THERAPY IN THROMBOPHLEBITIS

No.	Age and Sex	Veins Involved	Type Etiological	Symptoms Present at Time of Initial Blood Irradiation				Results	No. of Uvbit*	No. of Days in Hospital after Initial Uvbit
				Edema	Pain	Tenderness	Fever °f.			
1	40 F	LF	Postoperative (nephropexy)	+	+	+	99-104.4	Disappearance of pain, tenderness, and fever in 24 hrs., of swelling in 7 days.	1	11
2	30 F	LF	Postoperative (appendiceal abscess)	+	+	+	98-100.8	Disappearance of pain, tenderness, fever and swelling in 48 hrs.	2	11
3	33 F	LF	Postoperative	+	+	+	None	Disappearance of swelling, pain, and tenderness in 48-72 hours.	1	14
4	42 F	LF	Postoperative (hysterectomy)	+	+	+	99-101.6	Definite reduction of pain, tenderness, and swelling in 48 hrs., temperature falling to normal. All disappeared in 7 days.	1	7
5	32 F	LF	Postpartum	+	+	+	103.8	All symptoms began to subside in 48 hours.	1	22
6	18 F	LF	Post-Cesarean	None	+	None	102.0 staph-albus septicemia	Leg pain disappeared in 24 hrs., temperature normal after 2nd irradiation.	2	11
7	48 F	RF RS	Postinfections (infected varicose ulcer, erysipeloid skin lesion, lymphadenitis)	+	+	+	103.4	Pain, tenderness, edema disappeared in 5 days; skin infection also subsided in 5 days.	1	11
8	43 M	LF	Postinfectious, wound of foot	+	+	+	None	In 48 hrs. pain and tenderness subsided, but not edema; able to walk for first time, since onset of pathology.	1	8
9	24 F	LF RF	Postpartum	+	+	+	101-102	Pain, tenderness, swelling and fever disappeared in 12 hrs. Patient readmitted with feverless recurrence which subsided completely in 14 days; no further recurrence.	1 (recurrence)	5 14
10	47 F	LF	Postoperative (hysterectomy)	+	+	+	102	Pain, tenderness, and swelling gone in 5 days; temperature fell to normal on 6th post-irradiation day, after removal of heat cradle.	1	18
11	65 M	LF	Postinfectious (severe dental caries)	+	+	+	None	All signs of phlebitis disappeared in 15 days; teeth extracted, renal colic present, in remaining 13 days.	1	28
12	18 F	RS	Postpartum	+	+	+	99.6	Pain, tenderness gone in 10 days; fever and swelling in 72 hours.	1	7
13	32 F	RF LF	Postpartum (also pulmonary embolism)	+	+	+	103.8	Leg and chest pain, tenderness and fever disappeared in 48 hours; swelling in 4 days	1	7

Key LF—left femoral.
RF—right femoral.
RS—right saphenous.
LS—left saphenous.

* Uvbit—ultraviolet blood irradiation therapy.

severe pain and swelling of the right leg, giving a history of an uneventful delivery and puerperium one month previous to admission. Physical examination revealed extreme tenderness along the course of the internal saphenous vein popliteal space, Scarpa's triangle and the right parametrium. Bed rest, elevation of leg and sedation were all given this patient, as well as stilbestrol. Twenty-four hours later the patient's symptoms remained unrelieved, and ultraviolet blood irradiation therapy was instituted (200 cc. of patient's blood was irradiated according to the Knott technic) at 11 A.M., June 29, 1942. At 9 P.M. the same night, the patient stated that her pain had subsided completely, and it was obvious that the swelling, while still present somewhat, had diminished markedly. Her temperature which never exceeded 99.6°F. fell slowly to normal during the next seventy-two hours, and she convalesced uneventfully pain and swelling being completely relieved and temperature normal at time of discharge on July 6, 1942, seven days after a single blood irradiation.

It is interesting to note that case reports Nos. 8, 1 and 9 portray typical failures of nerve block and sulfa drug therapy to retard the progress of acute thrombophlebitis. In Case No. 10, the failure of classical conservative treatment by means of heat and elevation of the extremity is demonstrated. In Case No. 7, we find that ultraviolet blood irradiation therapy alone has been used, with a definitely decreased hospitalization time. This latter, in our opinion, represents ideal treatment for acute thrombophlebitis in that the progress of the diseased process is usually checked by one blood irradiation, although a second one may be occasionally necessary.

CLINICAL OBSERVATIONS

The following clinical observations have been made consistently. These findings are easily duplicated, having been produced thirteen times consecutively. In each patient suffering from acute thrombophlebitis, who received ultraviolet blood irradiation therapy, the various classical symptoms subsided in the following manner;

1. *Pain* was the first to disappear; usually the patient stated it had left sometime in the first twelve hours following ultraviolet blood irradiation therapy. In some instances pain disappeared in two or three hours after blood irradiation. The opposite extreme was noted in individuals in whom pain, though much less severe in twelve hours, persisted mildly for forty-eight to seventy-two hours, the longest period required for the disappearance of pain. This striking and rapid relief of pain was usually appreciated most by the patient.

2. *Tenderness* along the course of the affected vein usually disappeared completely two to six hours after the subsidence of pain. This phenomenon is the first objective evidence of blood irradiation controlling the progress of an acute thrombophlebitis.

3. *Fever*, if present, consistently was found to drop to normal in twenty-four to forty-eight hours. The only exception to this was in individuals in whom abscess formation was also present or occurring, in which event the temperature remained elevated between 99° and 101°F. until the abscess was evacuated.

4. *Edema* was the last symptom to disappear and its disappearance time varied from twenty-four hours to ten days.

5. *Coldness* of the extremity, when present, was said to disappear within twenty-four to forty-eight hours following initial ultraviolet blood irradiation therapy.

6. The fact that a new thrombophlebitis (Case No. 9) occurred after a previous one had subsided and two weeks after a blood irradiation, suggests that blood irradiation exerts no prophylactic protective effect, at least for more than two weeks; the fact that the newly occurring thrombophlebitis, in turn, subsided rapidly after ultraviolet blood irradiation therapy and did not recur, speaks for itself.

THEORETICAL CONSIDERATIONS

The appearance, following ultraviolet blood irradiation therapy, of several of the known biochemical and physiological effects of ultraviolet, notably the bactericidal,

detoxification and vasodilation effects, as well as the increase in venous oxygen values of individuals with abnormally low venous oxygen content, has been reported by Miley,⁴ Knott and Hancock,⁵ Rebbeck^{6,7} and Barrett.⁸

It seems rather unlikely that any of these four effects of ultraviolet, alone or combined, could completely account for the dramatic result observed in the thirteen cases reported. Therefore, it is not improbable that one or more other physiological or biochemical effects must be considered as partially responsible for this profound and rapid change in the status of the patient with acute thrombophlebitis.

In a recent report, Rebbeck and Miley⁹ stated they had made the observation that, in patients with peritonitis with advanced and prolonged paralytic or adynamic ileus, a rapid and consistent restoration of gastrointestinal to normal smooth muscle tone and contractility occurred, often twelve to twenty-four hours after a single blood irradiation. This was observable clinically in this short period of time by the expulsion of flatus, disappearance of abdominal distention, the reappearance of normal intestinal motility and the reappearance of normal abdominal auscultatory signs. Such an effect represents a restoration to normal balance of that part of the autonomic nervous system directly controlling smooth muscle tone and contractility of the abdominal portion of the gastrointestinal tract, a part of the autonomic system hopelessly out of balance before the application of ultraviolet blood irradiation therapy.

Continuing along this line of reasoning it is possible, in the light of the clinical effects observed in acute thrombophlebitis following ultraviolet blood irradiation therapy, to draw an analogy and point out that there also obviously occurs a restoration to normal tone and contractility of the smooth muscle elements of that portion of the peripheral vascular system directly affected by the pathology of acute thrombophlebitis. Again we find in turn a marked restoration to normal balance of those

automatic fibers innervating those blood vessels affected by the thrombophlebitis, fibers which previous to blood irradiation were in an advanced state of imbalance, as shown by their partial or complete atony.

Whether the effect of irradiated blood is directly on smooth muscle in the instances of paralytic ileus and thrombophlebitis mentioned, whether it is involved with the acetylcholine mechanism directly, whether it is a direct effect on peripheral or post-ganglionic autonomic fibers or a central effect, it is impossible to say. In view of the lack of evidence, especially in acute thrombophlebitis, of central and generalized autonomic nervous system imbalance, and in view of the purely local type of autonomic imbalance, one would consider a localized peripheral action of irradiated blood on that part of the autonomic system in a state of marked and obvious imbalance a distinct possibility. Against this view is the obvious fact that marked generalized peripheral vasodilation occurs with almost monotonous frequency following blood irradiation, that frogs irradiated externally with ultraviolet show vasodilation not only of the cutaneous capillaries but also of the capillaries of the large viscera; both of these effects are possibly due to direct stimulation of the medullary vasomotor centers, of preganglionic parasympathetic fibers, or to a diffuse, generalized post-ganglionic stimulation, and are not necessarily associated with a previously existing breakdown of autonomic nervous system control.

It is interesting to observe that the grossly discernible vasodilation effects noticed following application of ultraviolet blood irradiation therapy occurs in apparently normal humans, as well as in those who are suffering from various disease processes, whereas an increase in tone of normal gastrointestinal smooth muscle is not apparent, at least not to the extent that it produces colicky or cramp-like contractions. Likewise, as just stated, no evidence of an increase in smooth muscle tone, as in acute thrombophlebitis with edema, appears in normal individuals following blood

irradiation, but, on the contrary, only vasodilation. Therefore, it must be assumed that there exists a profound and fundamental regulating effect of irradiated blood upon the autonomic nervous system; this effect could be described as a "normalizing" effect and becomes most apparent in definite imbalance of the autonomic system.

In any event, there exists a close relationship between ultraviolet blood irradiation therapy on one hand and the restoration to normal of an autonomic regulatory mechanism hopelessly out of balance secondary to such pathological processes as found in paralytic ileus and acute thrombophlebitis. That this effect represents a subtle mechanism of an enzymatic or catalytic motive, is theoretically possible and suggests itself. A more simple theoretical explanation would be that individuals who respond to ultraviolet blood irradiation therapy so obviously, may be suffering from ultraviolet deprivation brought about by a breakdown, secondary to various disease processes, of the body's mechanism for absorbing ultraviolet, by an inadequate supply of ultraviolet, or by a combination of both.

Again we wish to emphasize that ultraviolet blood irradiation therapy produces some known and probably many unknown biochemical and physiological effects of ultraviolet energy and is not specific treatment for any disease. However, it is equally true that those disease processes which can be benefitted by the production of the aforementioned effects of ultraviolet energy probably will be controlled efficiently by ultraviolet blood irradiation therapy.

SUMMARY

1. In thirteen consecutive instances, individuals with acute thrombophlebitis were given ultraviolet blood irradiation therapy.

2. In all thirteen, a rapid disappearance of pain and tenderness was observed, usually within twenty-four to forty-eight hours following a single blood irradiation.

3. A drop to normal of abnormally high temperatures, when present, was found to occur within forty-eight to seventy-two hours.

4. Edema subsided completely in twelve of the thirteen cases, the disappearance time varying from thirteen to fifteen days. In the thirteenth case, a marked induration was associated with edema and neither had disappeared when the patient left the hospital on the eighth postirradiation day.

5. A complete absence of untoward effects in all patients treated was evident.

6. Of the thirteen cases, five were good examples of the failure of sulfa drugs plus local heat, bedrest, and elevation of the affected extremity to control thrombophlebitis; four received only ultraviolet blood irradiation therapy and bedrest; three had failed to respond to local heat, bedrest, and elevation of the affected extremity; and one represented the absence of any effect, in fifty days, of four therapeutic nerve blocks to influence the disease process; an apparent permanent indurative damage had occurred.

CONCLUSION

1. A new phenomenon, the relatively rapid disappearance of the classical signs of thrombophlebitis following ultraviolet blood irradiation therapy, has become apparent.

2. The excellent results observed in the thirteen consecutive cases reported warrants the further clinical application of ultraviolet blood irradiation therapy in individuals suffering from acute thrombophlebitis.

REFERENCES

1. MILEY, G. *Am. J. Surg.*, 57: 493, 1942.
2. MILEY, G. *Arch. Phy. Therapy*, 23: 536, 1942.
3. MILEY, G. *Habnemann Monthly*, 75: 977, 1940.
4. MILEY, G. *Am. J. Med. Sc.*, 197: 873, 1939.
5. KNOTT, E. K. and HANCOCK, V. K. *Northwest Med.*, 33: 200, 1934.
6. REBBECK, E. W. *Am. J. Surg.*, 54: 691, 1941.
7. REBBECK, E. W. *Am. J. Surg.*, 55: 476, 1942.
8. BARRETT, H. A. *Med. Clin. North America*, 24: 723, 1940.
9. REBBECK, E. W. and MILEY, G. *Rev. Gastroenterol.*, Jan.-Feb., 1943.

TOBACCO SMOKING AND CANCER OF THE LUNG

EDWIN J. GRACE, M.D.

Diplomate of the American Board of Surgery

BROOKLYN, NEW YORK

THE average clinician is slow in appreciating and applying, in clinical practice, the great advances made during the last half century in the basic sciences of chemistry, physics and biology. This approach becomes most important when we consider the increasing number of cancer cases which involve the respiratory tract, and examine, at the same time, the possible bearing which excessive smoking may have on this pathologic condition.

A comprehensive review of the literature on this subject has brought to light many interesting reports, but the experimental studies of Roffo,¹ conducted in Buenos Aires, demand, in my opinion, some comment, because of the great influence they might have upon an important phase of medical science, namely, that of preventive medicine.

After having had an opportunity to observe, over a period of ten years, an unusually large series of patients with cancer of the lung, in two of the large municipal hospitals in New York City, two very distinct elements were noted in these patients: First, the patients were almost always men; second, they were heavy cigarette smokers and almost always inhalers. There is no experimental proof at hand to demonstrate that the smoking of many cigarettes was the cause of lung cancer, however, some aspects of this problem should be carefully evaluated.

Roffo has shown, what seems extremely logical to me, namely, that a carcinogenic compound (benzpyrene) can be isolated from tobacco tar. This investigator has studied the action of tar, particularly tobacco tar, upon the human organism. He found that the latter is more active and malignant than coal tar, and that 95 per cent of all cancers of the lung, larynx

and pharynx occur in smokers. Mortality among smoking patients afflicted with cancer mounted from 148, in 1926, to 513, in 1937. These observations and chemical investigations indicated that the carcinogenic agent is not contained in the nicotine but is a component of the products of combustion of tobacco while smoking. He finally isolated the actual carcinogenic component (benzpyrene) from tobacco tar by fractional distillation at a temperature of more than 380°C. Experiments with this substance revealed that it is highly carcinogenic, and causes invasive, expanding and destructive proliferations. The primary lesions appear earlier than those caused by the use of total tobacco tar. On the basis of these observations, Roffo concludes that tobacco benzpyrene is responsible for the carcinogenic action found in tobacco tar.

It is obvious, therefore, that this product of combustion deeply inhaled into the lungs of cigarette smokers—for cigarette smokers usually inhale—is deposited in the lung along the entire bronchial system, and most of the biologic principles are present, I believe, to produce bronchogenic carcinoma in accordance with well known animal experiments.

The three cases which were studied at this Clinic were all heavy smokers, and all had inhaled over a period of at least fifteen years. All three had a very active and inoperable cancer, with metastases, and died as a result of this disease.

CASE REPORTS

CASE 1. W. D., a male, age forty, came to the Clinic, March 24, 1937, with a history of numerous head colds, developing during short intervals, combined with sore throat, and followed by a dry, hacking cough. There was a small amount of thick, blood-streaked sputum.

This patient had been gassed during World War I, and at that time had been ill for four months. His father had died of a brain tumor.

and, microscopically, it was a Grade IV tumor, probably a bronchogenic metastasis.

The general condition seemed fair during

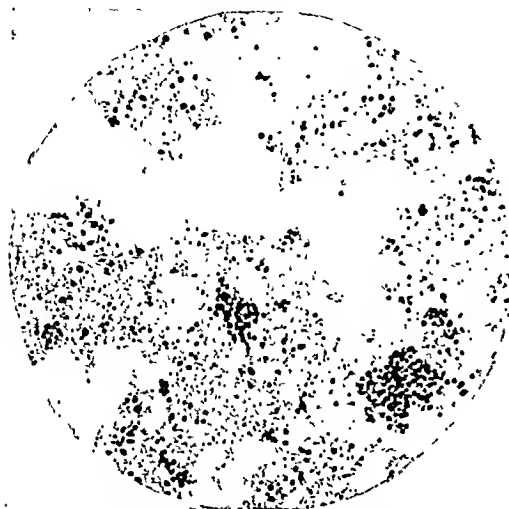


FIG. 1. Case 1. Microphotograph taken at operation.

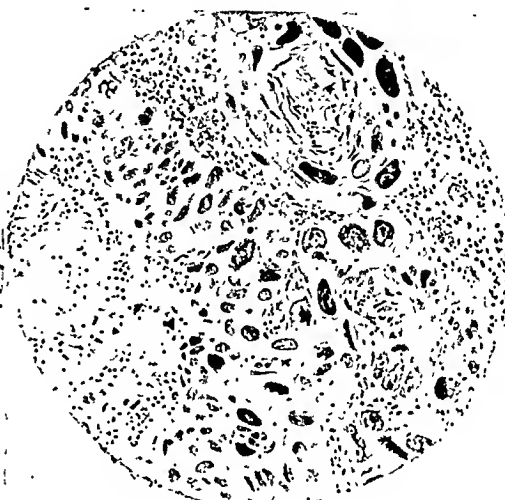


FIG. 2. Case 11. Microphotograph taken at operation.

The patient had been losing weight. There was no fever or night sweats and no chest pain. Sinus trouble had been present for some time, and it became worse on March 26, 1937. Roentgenograms taken shortly before this time revealed a possible tuberculous lesion at both apices, which was of minimal extent, of fibrotic appearance, and apparently arrested. However, a mass-like infiltration was noted extending from the upper part of the left cardiac border into the first and second left intercostal spaces. No tubercle bacilli were demonstrable. Fluoroscopy of the esophagus showed that the latter was pushed over to the right of the level of the pulmonary lesion.

On September 14, 1937, exploration of the left thoracic cavity was made by an anterior approach between the second and third ribs. The upper mediastinal area was entered and a tumor mass found which was fixed and obviously inoperable. The tumor occupied the entire three-fourths of the upper part of this cavity, and was confluent with an adherent mass in the upper left lobe. In view of the inoperability of the tumor, fifteen seeds of radium emanation were implanted into the mediastinum. There was no gross evidence of metastases on the surface of the left lung, but the primary tumor was probably in the periphery of the left upper lobe.

A biopsy of the mediastinal mass was taken

repeated check-ups, the radon seeds having apparently helped the mediastinal obstruction. In August, 1938, he complained of pain in the left forearm, with numbness in the fifth finger. His cough was becoming worse, and was accompanied by nausea and vomiting. He subsequently developed a classical Horner's syndrome. The patient continued to lose weight, and all symptoms grew progressively worse. Death ensued shortly afterward.

CASE 11. F. R. P., a male, age fifty-four, reported to the Clinic, in March, 1940, with a history of having had a slight cough for two or three years. During the past three months there had been some pain in the left shoulder, radiating to the hand. The patient was losing weight and had moderate hemoptyses. Roentgenograms, taken elsewhere, showed marked infiltration in the left upper lobe, with a large cavity just below the level of the clavicle, strongly suggestive of pulmonary tuberculosis. One positive sputum was obtained. The best method of treating the condition appeared to be an upper-stage thorocoplasty. At operation, there was found, between the third and fourth ribs, a protrusion about the size of a small egg, grossly, suggestive of a neoplasm.

Pathologic examination revealed bronchogenic carcinoma, Grade II. No tuberculosis was found at any time in the many tissues involved.

Shortly before his death a classical Horner's syndrome developed, probably as a result of the spreading neoplasm. The patient died three months postoperatively.

CASE III. A. H., a male, age thirty-nine, complained of pain in the chest, chronic cough, and loss of weight during the six months preceding his visit to the Clinic (October, 1941). Roentgenograms revealed atelectasis and fluid in the left side. Bronchoscopic examination demonstrated a neoplasm involving the left main bronchus. Operative exploration was undertaken through an anterior approach. Adhesions were found throughout most of the pleural space, which were unusually dense over the left lower lobe, where they were firmly adherent to the chest wall and diaphragm with numerous metastatic implants. Surgical removal was not possible.

A biopsy of the lung showed bronchogenic carcinoma, Grade III.

The patient died, January 2, 1942, with generalized metastases involving the pericardium, pleura, pancreas and stomach, with the primary site in the left lung.

I believe the three cases discussed here bear out the theory of Roffo, that possibly the carcinogenic irritants from tobacco tar are deposited in the lung, and the end result of this irritation, in a biologically susceptible individual, is the production of a bronchogenic carcinoma.

In spite of all the technical improvements of dealing with cancer, we, at present, cannot successfully cope with high grade neoplasms of the lung, and the low grade tumors which give a better prognosis surgically, represent a badly handicapped group of individuals.

In attempting to analyze these cases of cancer of the lung using tobacco smoking as the causative agent, we note data that might be productive of important preventive measures. Cramer, in discussing the many causes of cancer, and from experimental evidence at present available, when applied to man, established four distinct groups: (1) Carcinogenic agents, (2) precancerous conditions, (3) susceptibility, and (4) time factor.

In applying Cramer's grouping to the

three cases herewith reported, in Group I (carcinogenic agents), we find a very potent carcinogenic compound (Benzpyrene) in



FIG. 3. Case III. Microphotograph taken at operation.

the tar of smoking tobacco that all these patients deposited in their lungs.

Regarding Group II (precancerous conditions), Dr. Cramer reports that "during the prolonged period of induction necessary for a carcinogenic agent to elicit cancer, the tissue on which these agents act undergoes a pathologic change, and it is in this altered tissue that eventually a malignant condition develops in a sharply circumscribed area." We believe that in our three cases this etiologic factor was probably produced by tissue alteration from the constant inhalation of the tar with its carcinogenic agent.

Group III (susceptibility) cannot be directly applied to any of these cases with certainty, except possibly in Case I, where the history states that his father died from brain tumor. However, the mere fact that a tumor did develop shows that some degree of susceptibility may have existed, which might have been stimulated by a

carcinogenic agent. In genetically susceptible individuals. In spite of these apparent imponderables, in attempting to establish scientific facts, Cramer states: "The relationship between the two factors susceptibility and carcinogenic agent can be expressed crudely by a simple equation of two variables A and S , and a constant, C : $A \times S = C$. In such an equation the one variable increases as the other diminishes. If A represents the carcinogenic agents, S the susceptibility, and the constant C the carcinogenic effect, the equation expresses the fact that cancer can arise in an organism either with a high susceptibility and a weak carcinogenic stimulus or with a low susceptibility and a strong carcinogenic stimulus. The equation reads therefore: Carcinogenic agent \times susceptibility = carcinogenic effect." It is believed that the three cases reported partly fulfill these requirements.

In Group IV (time factor) all these cases more than fulfill this time requirement. Their ages being forty, fifty-four and fifty-nine, respectively, the period of smoking with the induction of tar, with its carcinogenic compound, into the lung was a minimum of twenty years. The significance of this time factor is obvious because "the production of cancer by coal tar requires on the average six months in a mouse and fifteen years in a man. With a life span of

two years for a mouse and seventy years for a man, six mouse-months represent one-fourth of the life span of a man. During this long period of induction the tissue on which the carcinogen acts undergoes a series of pathologic changes involving among other things increased cell division. Eventually this altered tissue passes into a condition in which a few cells within this altered tissue undergo, sooner or later, an irreversible intracellular change which transforms them into malignant cells. When this happens the scene changes from the exterior to the interior of the cell."

CONCLUSIONS

In three proved cases of cancer of the lung, it would seem logical to assume that possibly in some biologically susceptible individuals, the carcinogenic agent in the tar of smoking tobacco might be the causative factor. Using clinical data, and coordinating it with studies in the basic science of chemistry and biology, further evidence is suggested to confirm our opinion that the gravity of this habit of smoking should be clinically emphasized.

REFERENCES

1. ROFFO, A. H. Correlation between carcinogenic action of tobacco tar and coal tar. *Prensa méd. argent.*, 28: 1003, 1941.
2. CRAMER, W. The origin of cancer in man. *J. A. M. A.*, 119: 309, 1942.



THE VALUE OF AUSCULTATION OF THE ABDOMEN IN THE DIAGNOSIS OF ACUTE APPENDICITIS

N. C. STEVENS, M.D.

Associate Attending Physician, Elliot Community Hospital, Keene, New Hampshire
WALPOLE, NEW HAMPSHIRE

THE cardinal symptoms and physical signs of acute appendicitis are so well known it is not necessary to discuss them in this article. The writer will confine himself to the discussion of the value of auscultation of the abdomen in the diagnosis of acute appendicitis. So little attention has been paid to the significance of the peristaltic rate in its relation to some functional and organic conditions of the abdomen, it might be well to state what the normal rate is and its variations in functional disturbances and organic diseases.

The peristaltic rate in a healthy young adult varies between five and ten tinkles a minute. After a meal there may be a slight increase in the rate. The tinkles are high pitched and faint in character. They resemble the sound of water dropping into a well from a height. The rate is influenced by the condition of the nervous system, indiscretions of diet, alcohol and by certain organic conditions such as acute appendicitis, perforated gastric ulcer and intestinal obstruction. It is influenced by diseased conditions in other parts of the body, by high temperature, and by certain drugs. This article is concerned with the effect of inflammation of the appendix upon the peristaltic rate.

At the beginning of an attack of acute appendicitis the peristaltic rate is increased. At this stage the inflammation acts as an irritant with stimulation of the autonomic nerve endings and an increase in the rate. As the inflammation proceeds and the outer coat of the appendix becomes involved peristalsis diminishes. When the peritoneum becomes involved by a leakage of exudate, peristalsis ceases altogether and the abdomen becomes silent. Cessation of

peristalsis seems to depend upon infection or irritation of the peritoneum. In cases of retrocecal appendicitis with the appendix lying outside of the peritoneum the peristaltic rate is apt to be accelerated and has a characteristic muffled sound, faint and distinct, which can be best described as "scratchy." After rupture of an appendix with the exception of retrocecal appendicitis, the abdomen remains silent until extension of peritonitis ceases and inflammation becomes localized. Then peristalsis begins again. After rupture of an appendix the abdomen may remain silent from twenty-four to forty-eight hours.

If the peritonitis becomes localized and an abscess forms in the right lower quadrant, partial obstruction may occur which stimulates the peristaltic rate to overcome the obstruction.

There is a large group of cases characterized by right lower quadrant pain, tenderness, spasm, a rise in temperature and pulse rate and possibly a slight increase in the blood count as well as nausea and vomiting that are not due to inflammation of the appendix. All the cardinal signs and symptoms can be simulated by a spastic cecum and a collection of gas in the right lower quadrant. Fortunately, in this condition peristalsis is usually hyperactive and may be continuous which is the reverse of that which occurs in acute appendicitis. As a rule symptoms subside very quickly after an enema, or a hypodermic injection of sodium luminal.

A great many of these patients are operated upon and a normal appendix is removed at operation. A word of caution must be added here. Not all silent abdomens are due to peritonitis. In some cases of

acute indigestion due to indiscretions of diet, alcohol, extreme fatigue or nervous tension there is spasm at the pylorus which seems to effect the motility of the entire gut. In this condition no sounds are heard over a considerable period, which with the associated pain and occasional nausea and vomiting, might lead one into the error of believing that a surgical condition exists. A large dose of sodium luminal given hypodermically will relieve this condition in a short time. Usually within twenty five minutes after the injection peristalsis begins, the pylorus opens and gas and stomach contents begin to pass along; at this point the pain and discomfort usually disappear.

Attacks of periodic vomiting, especially in children, are quite common. The vomiting may be associated with pain but usually is not. The vomiting may continue for hours and even days. In these cases there is also spasm at the pylorus and the abdomen may be silent for long periods of time.

CASE REPORTS

CASE I. On December 21st, a garage man, aged thirty-two, began to have pain in his abdomen. At the beginning the pain was cramp-like in character, worse after eating. Next day the pain was general and was worse than the preceding day. He felt nauseated, but did not vomit. In the evening he had a temperature of 99°F. A physician was called who made the diagnosis of intestinal grippe and advised a cathartic and enema. The result from the enema was not satisfactory. The following day, December 24th, the patient was much worse. The pain had localized in the right lower quadrant and his abdomen was distended. He had had no movement of the bowels and an enema was unsuccessful. The next day I was called in to see him. He appeared acutely ill, his face was flushed, his tongue coated and dry. His abdomen was considerably distended, there was tenderness over the entire abdomen, but most marked over the right lower quadrant. There was rigidity in the right lower quadrant. On auscultation peristalsis was entirely absent. His blood count was 18,000, with 85 per cent polymorphonuclears.

The patient had been operated upon for appendicitis several years ago, and an inflamed appendix was said to have been removed. It was evident that the patient had an acute condition of the abdomen, but due to the fact that an appendectomy had been performed I thought the most probable condition was intestinal obstruction. His immediate removal to the hospital was advised. A consultant was called who advised an immediate operation. At operation an abscess was found in the right lower quadrant resulting from a gangrenous stump of the appendix which had not wholly been removed at the previous operation. The abscess was more or less walled off, but there was a considerable area of the peritoneum involved. He had a very stormy time for three days following the operation and it was thought he could not survive. However, after the third day he began to improve and made an uneventful recovery.

For auscultation to be of any value it is necessary to listen at intervals over a period of time, from one-half to three-quarters of an hour. Peristalsis may be absent at one examination, but not at another.

CASE II. A laborer, fifty-two years old, began to have pain in his abdomen on the evening of November 21st. The pain was intermittently severe, first general and then becoming more intense in the right lower quadrant. He vomited several times during the night and the day following. His bowels had not moved for two days. On November 23rd, he called a doctor for the first time. His temperature was 99.5°F. There was tenderness and rigidity in the right lower quadrant and marked tenderness on rectal examination.

The same evening I saw the patient in consultation. The temperature was then normal and the tenderness and rigidity had diminished somewhat. On auscultation of the abdomen the peristalsis was loud and continuous. My advice was to give the patient an enema and to wait.

The next morning the pain had disappeared; there was no tenderness or rigidity, only a slight soreness remaining. The peristaltic rate was almost normal. Following the enema the patient had had a large evacuation. The following day he left the hospital.

There are a large group of cases characterized by right lower quadrant pain and tenderness that simulate acute appendicitis very closely. This is due to either constipation, indigestion, or to a spastic cecum, a condition very common in nervous people. Gas collects behind the spastic segment, and very severe pain may ensue.

Recently I saw a case that simulated the picture of the perfect textbook case of acute appendicitis. A boy eight years old began to have pain in the abdomen about 9 A.M. During the morning he vomited several times. About 4 P.M. the pain shifted to the right lower quadrant. His mother became alarmed and called me in to see him. On physical examination the face was flushed, the tongue coated, the temperature $99\frac{1}{2}^{\circ}\text{F.}$, pulse 90. The tenderness was marked in both lower quadrants, more so on the right. Peristalsis was intermittently very active, loud gurgling sounds followed by silent intervals. An enema was given which brought away a considerable amount of flatus and hard fecal matter. Inside of half an hour the child was perfectly comfortable, and the peristalsis was diminished.

A large percentage of these patients are operated upon and a normal appendix is removed. Nearly all the cardinal signs of acute appendicitis may be present: pain and tenderness in the right lower quadrant, nausea or vomiting, a slight elevation of temperature. In one case I saw, there was even a rise in the blood count to 15,000. However, in these cases the peristaltic rate is usually increased, and may be continuous. Very often the abdomen becomes so noisy that the patient himself is conscious of it. I have yet to see a case of acute appendicitis approaching rupture with a noisy abdomen. As a rule the symptoms subside very quickly after an enema. A hypodermic of sodium luminal is useful in relieving the spasm.

CASE III. A boy, aged twelve, complained of pain in his abdomen at noon. The pain increased in severity during the afternoon. It was localized mostly in the epigastrium. He vomited several times.

At 6 P.M. I was called in to see him. He looked

rather acutely ill. The tongue was not coated; throat and chest were normal. There was a slight fullness to the abdomen. The tenderness was general, probably more in the right lower quadrant than elsewhere. There was no rigidity. On listening to the abdomen over a period of fifteen minutes no peristaltic sounds were heard. The temperature was 99.5°F. and the pulse rate 95. The white blood count was 18,000 with 90 per cent polymorphonuclears.

His immediate removal to the hospital was advised. Just before operation the abdomen was still silent.

At operation a swollen, moderately congested appendix was found directly beneath the incision on the peritoneum. It was lying free and almost touching the peritoneum, so no handling of the intestine was necessary. The appendix was covered with fibrin. It was removed without difficulty. In all probability it was several hours away from rupture.

This patient was operated upon eight hours after the onset of symptoms. The abdomen was silent at the end of six hours. Peristalsis may have been absent for sometime previous to my visit. Peristalsis stopped early because the appendix was lying free and close to the peritoneum.

A good rule in suspected cases of acute appendicitis is that with increasing pain in the right lower quadrant and decreasing peristalsis the chances of an inflamed appendix are strong.

CASE IV. On May 11th, at 4 P.M. a lady, age thirty-five, came to my office complaining of pain in the right lower quadrant. She said that for the past ten days she had had cramp-like pains in her abdomen, that they had been general up to the day she had come to see me, and that during the last twenty-four hours had localized in the right lower quadrant. She had been up and around and able to do her work, and had worked all day up to the time she came to see me. She had not vomited nor had she been nauseated. She had lost eight pounds in the last ten days. Her temperature was 99°F. On examination the abdomen was soft except in the right lower quadrant where there was rigidity and extreme tenderness. A mass was felt which could be rolled under the fingers and gave the impression of a distended loop of gut. A rectal examination was entirely negative. The white blood count was 12,000 with 80 per

cent polymorphonuclears. Listening at intervals over a period of three-quarters of an hour, I heard no peristaltic sounds whatever.

I told her that I thought she had a ruptured appendix and should be in the hospital. She expressed considerable surprise at the diagnosis and did not like the idea of going to a hospital. She did not agree with my diagnosis, as she did not see how it was possible to have a ruptured appendix and be able to walk around and keep at her work. She went home undecided what she would do. Later in the evening her employer called me and asked for a consultation. The next morning a surgeon called to look at her. She was feeling much better, had very little pain, her temperature was normal, the mass which I had felt the afternoon before had disappeared, there was practically no rigidity and very little tenderness. The surgeon did not think she had an appendix and advised her to get up and go about her work.

I did not see her again that day, but went to see her the next morning, May 13th. She was not feeling very well. She complained of cramp-like pains in her right lower quadrant. She had had a chill which lasted for fifteen minutes the night before and had vomited once. On examination there was again some rigidity in the right lower quadrant and a moderate amount of tenderness. A definite tender mass could be felt easily. The blood count was 14,000 with 85 per cent polymorphonuclears. Peristalsis was audible at this time as it had been the previous morning when the surgeon examined her. I reported the results of my examination to the surgeon and he advised her immediate entrance to the hospital.

At operation upon opening the peritoneum there was a moderate amount of free fluid. The appendix was very large, red and adherent to the cecum and lateral abdominal wall. The omentum had almost completely encircled it except where it touched the peritoneum. At this point of contact it had ruptured and was gangrenous.

When I first saw this patient the appendix either had ruptured or was on the point of rupturing. The next morning she was feeling better with practically no pain. Peristalsis which had been absent the afternoon before was infrequently audible which meant that the abscess was walled off and extension of peritonitis had ceased. The return of her symptoms on the third day was probably due to

increase in size of the abscess and absorption of pus.

CASE V. A laborer, age twenty-two, while eating supper on the evening of November 25th, began to have severe generalized abdominal pain. Toward the middle of the night the pain became so severe he called a doctor. About this time the pain had localized in the right lower quadrant. On examination there was tenderness in both lower quadrants and most marked in the midline below the umbilicus. The abdomen was soft and there was no rigidity. At that time the doctor was doubtful whether there was any surgical condition. During the night the patient vomited several times. His temperature was 99°F. The pain persisted all night and the next day, but it was not so severe as to prevent him from sleeping at intervals. I was asked to see him in consultation in the afternoon about 3 P.M.

He complained of moderately severe pain. The temperature was 99.5°F. He had not vomited for over twelve hours. He had taken a cathartic the night before and his bowels had moved well in the morning. The abdomen was fairly soft; there was no rigidity, but a slight fullness in the middle line below the umbilicus. Tenderness was marked in both lower quadrants. The peristaltic rate was increased, but muffled and faint in character. The patient was sent to the hospital for observation. I saw him again in consultation at 9 P.M. the same day. In the meantime he had been given an enema which had not relieved the pain. The physical signs were the same as at the previous examination, except the abdomen was entirely silent. Listening at intervals over a period of twenty minutes revealed no sounds whatever. Operation was advised and performed at 10:30 P.M. A large, inflamed appendix about the size of the middle finger was found. It was pointing toward the middle line.

This patient was operated on twenty-seven hours after his pain began. Peristalsis was heard at 3 P.M. It ceased somewhere between 3 and 9 P.M. The appendix had not ruptured at the time of operation. From its appearance it might not have ruptured for another four or five hours.

CASE VI. A fourteen year old boarding school girl began to have abdominal pain during the morning of January 4th. The pain was fairly general, and during the morning and afternoon it was especially severe. During the evening the pain increased in severity and

became localized in the right lower quadrant. She was slightly nauseated but had not vomited. A surgeon was called who made a diagnosis of acute appendicitis, and advised her removal to the hospital.

Her temperature upon arrival was 99.6°F., pulse 100, white blood cells 9,000, polymorphonuclears 78 per cent, urine examination negative. On physical examination there was tenderness over McBurney's point and a suggestion of rigidity. On rectal examination there was marked tenderness in the right pelvic region.

The attending surgeon called up the child's parents and advised an immediate operation. The parents requested that another surgeon and myself be called in consultation before the operation was performed. On our arrival at the hospital three hours later, the symptoms and physical signs were unchanged, except that the white cells count had dropped from 9,000 to 7,000, and the polymorphonuclears from 78 to 75 per cent. On auscultation of the abdomen peristalsis was active and loud.

The surgeon who had been called in consultation did not think an immediate operation was necessary and advised keeping the child under observation at the hospital for a day or two. One of us was of the opinion she did not have acute appendicitis, that the pain and tenderness was due to gas and spasm in the cecum, and that an enema was indicated.

Shortly after arrival at the hospital she had another attack of pain, and there was some tenderness and spasm in the right lower quadrant. Her temperature was 99.5°F. and the blood count rose to 15,000. Peristalsis was active. The surgeon was quite sure that she had an acute appendicitis and gave orders that she be prepared for operation. I still was not convinced that she had an acute appendicitis and suggested that she be given an enema before she went to the operating room. This was done and a good deal of hard fecal material came away with the enema. A few minutes later the pain disappeared and she felt perfectly comfortable. Two hours later the temperature and blood count had returned to normal.

The attack occurred three years ago. She has had no trouble since that time.

This girl presented all the cardinal signs of acute appendicitis, pain, tenderness and slight rigidity in the right lower quadrant, a

slight rise in temperature and a blood count of 15,000. However, peristalsis was active from the beginning to the end of the attack which is not characteristic of acute appendicitis. At the beginning of an attack peristalsis is usually increased, but as the inflammation progresses, peristalsis diminishes and ceases altogether when the outer coat of the appendix becomes involved.

CASE VII. A college student, twenty-one years of age, was awakened by severe pain in the epigastrium at 4 A.M. Between then and 7 A.M. he vomited several times. He refused breakfast. He walked one mile from his room to the campus. There was no letup in the pain. The pain was so severe that he decided to go to the infirmary instead of to his classes. By this time it was beginning to localize in the right lower quadrant.

On physical examination his temperature was 99.5°F., pulse 85, white blood count 25,000, polymorphonuclears 85 per cent. There was tenderness and moderate rigidity in the right lower quadrant. At 9:30 A.M. the attending physician noted active peristalsis. At 11 A.M. another physician listened to his abdomen and made a note that there was only an occasional gurgle. At 11:45 A.M. the abdomen was silent.

He was operated upon at noon. The appendix was lying free and was exposed without difficulty. It was swollen and congested. The tip was darker in color and looked as if it might soon be gangrenous. It was probably two or three hours away from rupture.

There was a period of eight hours from onset of pain to the time of operation. Peristalsis was active at 9:30 A.M., considerably decreased at 11 A.M. and entirely absent at 11:45 A.M.

CONCLUSIONS

1. Auscultation is a valuable supplement to the symptoms, physical signs and blood count in arriving at a diagnosis of acute appendicitis.

2. At the beginning of an attack of acute appendicitis, the peristaltic rate is usually increased. As the inflammation progresses, peristalsis diminishes. When the outer coat of the appendix becomes involved, peristalsis ceases altogether and the abdomen becomes silent. Conversely the writer has

never seen a case of acute appendicitis at or near the time of rupture with a noisy abdomen.

3. Cessation of peristalsis seems to depend upon infection or irritation of the peritoneum. In cases of retrocecal appendicitis, peristalsis does not cease entirely but becomes faint and muffled, which can best be described as "scratchy."

4. Not all silent abdomens are due to peritonitis. In some cases of acute indigestion there is spasm of the pylorus which seems to effect the motility of the gut. In this condition no sounds are heard over a considerable period.

REFERENCES

- KING, J. E. Postoperative abdominal auscultation. *Am. J. Obst. & Gynec.*, February, 1930.
- STEVENS, NEIL C. Auscultation of the abdomen in the diagnosis of hypermotility. *New York State J. Med.*, July, 1931.
- JAMES, T. G. The value of auscultation of the acute abdomen. *Practitioner*, no. 790, April, 1934.
- STEVENS, N. C. Auscultation of the abdomen an aid to diagnosis. *New England J. Med.*, July 19, 1934.
- STEVENS, N. C. Auscultation of the abdomen. *New England J. Med.*, July 2, 1936.
- VAUGHAN, R. T. and THOREK, P. Abdominal auscultation. *Am. J. Surg.*, August, 1939.
- McSWAIN, BARTON. Auscultation in the diagnosis of surgical diseases of the abdomen. *J. Tennessee State Med. Asso.*, November, 1939.
- STEVENS, N. C. The value of auscultation of the abdomen in intestinal obstruction. *New England J. Med.*, January 15, 1942.



PELVIC inflammation brings about menorrhagia through hyperemia (in the acute stages), congestion (in the chronic stages), and fibrosis.

EXPERIMENTAL OSTEOMYELITIS*

LOUIS SCHEMAN, M.D.,†

PHILIP LEWIN, M.D.,†

Associate Professor of Bone and Joint Surgery,
Northwestern University Medical School

SIDNEY SIDEMAN, M.D.†

AND

MARTHA JANOTA, M.S.

Associate in Orthopedics, Michael Reese and
Cook County Hospitals

Research Assistant in Bacteriology, Michael Reese
Hospital

CHICAGO, ILLINOIS

THE results of experiments through which osteomyelitis was reproduced by us in animals are discussed in the present paper. The thesis is easy to understand; the experiments are easily repeated and the report offers incentive for further experimentation. The technic used in the production of hematogenous osteomyelitis was set forth in a preliminary report.†

At that time only young rabbits were used; since then older rabbits and dogs have been utilized. In practically every instance the method has been successful in producing osteomyelitis in the tibia selected. *Staphylococcus aureus*, originally cultured from a child with hematogenous osteomyelitis, was used without attenuation. The organism as taken from the agar medium, is diluted before injection.

The rabbits receive a preliminary immunizing dose. One week later sodium morrhuate is injected into the metaphysis of the tibia. A half hour later the organism is injected into the metaphysis of the same tibia and osteomyelitis develops. Some animals are given the organism intravenously and the osteomyelitis develops only in the tibia which had the morrhuate injection. Without the preliminary immunizing dose, most of the rabbits die from the disease. In dogs, however, oste-

omyelitis can be produced and the animals kept living without the immunizing dose.

The lesion resulting is a pan-osteitis rather than a localized bone abscess. It is a phlegmonous process involving all the elements of the bone, and resembles the disease as it occurs in man. The basic principle operating in the development of a true osteomyelitis is a suitable preparation of the bone. In the experiments here reported this preparation was accomplished by the intrametaphyseal injection of sodium morrhuate.

Under the microscope morrhuate may be noticed as producing bone necrosis, particularly in the region of the osteoid columns. It almost always brings about considerable endosteal reaction, and the inner shaft-trabeculae show evidence of necrosis. We have never seen any evidence of vascular thrombosis. All of the small vessels visualized in morrhuate-control bones are patent. When in direct contact with bone elements, the morrhuate obviously exerts a localized toxic action to be expected, since the marrow spaces have no anatomic communication with the blood vessels. Our injections were made into the metaphysis and hence into the marrow spaces.

The morrhuate does just damage enough so the bacteria are enabled to produce osteomyelitis. In other words, our use of the morrhuate supplied the unknown

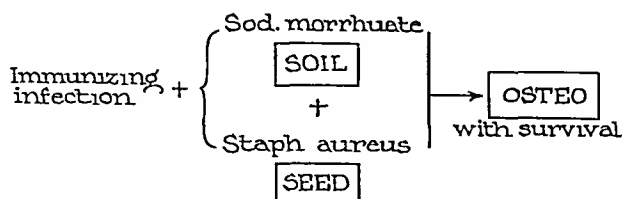
‡ J. A. M. A., 117:1525, 1941.

* From the Department of Orthopedic Surgery, Bacteriology, Pathology and Roentgenology of the Michael Reese Hospital, Chicago. This work was made possible by two grants from the Merriell Abbott and Lilly Marks Funds for Crippled Children. Read before the Meeting of the American Academy of Orthopedic Surgeons, Atlantic City, New Jersey, January 12, 1942.

† Drs. Scheman, Lewin and Sideman are now on active duty in the service of the U. S. Dr. Scheman is a Captain; Dr. Lewin is a Lieut. Colonel, and Dr. Sideman is a Lieut. Commander.

factor by providing the soil. Trauma or intrametaphyseal injection of staphylococci, whether virulent or attenuated, will embolism may do it in man.

Formerly, osteomyelitis in man was result in a true osteomyelitis.



1st WEEK	2nd WEEK	3rd WEEK	4th WEEK
{ Sod. morrhuate Staph. aureus injected into metaphysis	Osteo	30% survival	No survivals
Sod. morrhuate injected into metaphysis Staph. aureus injected intravenously	Osteo	40% survival	No survivals
Immunizing subQ injection Staph. aureus	{ Sod. morrhuate Staph. aureus injected into metaphysis	Osteo 90% survival	Animals sacrificed

FIG. 1. Scheme outlining method for the experimental production of osteomyelitis

thought due to vascular thrombosis and infection. Morrhuate was selected as the thrombotic agent, the belief that it acted in this manner lasting until observed necrosis of the bone convincingly annulled it. The evidently direct action of the morrhuate on the osteoid columns and endosteal bone produces local bone damage but no thrombosis of vessels. The morrhuate does not penetrate the blood vessels. It does enter the marrow spaces. A certain amount of irritative necrosis of the bone ensues. When *Staphylococcus aureus* is implanted on this soil by either the intravenous or the metaphyseal route, an osteomyelitis invariably develops.

From the results of a large number of experiments, it may now be considered certain that unless the proper soil exists in the bone, neither intravenous nor

The necrosis produced by the injection of sodium morrhuate into the metaphysis is not severe. Unless infection supervenes, complete regeneration is noted in about three and one-half weeks. (Fig. 8.) The necrosis is barely evident in roentgenograms. In some there is slightly increased density of a diffuse nature; in others there are areas of rarefaction; in many, no detectable change.

Abundant evidence substantiates the thesis that in the natural history of this disease bone damage occurs early and precedes the development of the panosteitis. The end result of the morrhuate injection is, therefore, damaged bone. The result of its infection is osteomyelitis.

The roentgenographic picture and the pathologic specimens are comparable with those seen in human osteomyelitis. Some

of the local pathologic changes so characteristic of the disease in man, which we have reproduced experimentally, are:

metaphyseal) is involved. There are large collections of polymorphonuclear cells and some necrosis of bone trabeculae; new bone



FIG. 2. A, osteomyelitis of right tibia of four weeks' duration produced by the intrametaphyseal injection of .3 cc. of sodium morrhuate followed in one hour by the injection of .2 cc. of a $\frac{1}{50}$ dilution of a broth culture of hemolytic staphylococcus aureus. B, same rabbit as in 2A fifty-three days after the induction of osteomyelitis. Healing is evident; epiphysis and knee joint are not involved.

changes in circulation, emboli, infarction, anemia, necrosis, sequestration, involucrum formation.

Consequently we believe we have a reliable method of producing experimental osteomyelitis in rabbits and dogs, which is capable of further development.

Our experiments re-affirm the following facts: (1) The firm attachment of periosteum at the epiphyseal line safeguards the neighboring joints. (2) The epiphysis is a strong barrier against the spread of infection. (3) Spread of the infection to a joint is unusual (except in the hip).

In the majority of osteomyelitic tibias the neighboring epiphyseal plate (juxta-

is laid down at the epiphyseal line, and with longitudinal growth the area of necrosis gradually is separated from the epiphyses. Rarely has there been destruction of the epiphyseal plate and involvement of the epiphyses and the joint.

In one animal we noticed complete destruction and restoration of a whole epiphyseal plate three weeks after morrhuate injection. This was in a control, i.e., a non-infected animal. The process of regeneration following the damage produced by the morrhuate is remarkable for its rapidity. In most cases the regeneration is well advanced in three weeks.

In an animal which had an osteomyelitis of the tibia produced by sodium morrhuate and intravenous *Staphylococcus aureus*,

damage it produces is not extensive and is practically microscopic. We have seen in morrhuate-control animals complete repair



FIG. 3.



FIG. 4.



FIG. 5.



FIG. 6.

FIG. 3. Osteomyelitis of the right tibia seven weeks after experimental induction. Note marked thickening and periosteal new bone formation.

FIG. 4. Experimental osteomyelitis of the right tibia in rabbit two and one-half weeks after induction. Note that the epiphyseal plate and epiphysis are intact. Sequestration of the tibial shaft, involucrum formation and large soft tissue abscess are evident.

FIG. 5. Right tibia of rabbit eight weeks after experimental induction of osteomyelitis. Healing is well advanced. Note sequestrum in midshaft.

FIG. 6. Experimentally induced osteomyelitis of the left tibia seventeen days old. Note cortical destruction of extensive degree.

a metastatic osteomyelitis lesion appeared during the third week in the lower part of the left femur. This is the only instance of metastatic osteomyelitis in the whole series.

We are convinced that the earliest lesion in osteomyelitis is damage to bone tissue. Whether in man the soil is provided by trauma, or whether necrosis and infection are concomitantly due to an infected embolus, remains unknown. Our own experiments seem to prove that changes in bone once initiated, constitute primarily a local phenomenon, with, of course, the possibility of metastasis. The receptive soil for an osteomyelitis is damaged bone. Bacterial infection alone does not produce osteomyelitis; it must lodge in a receptive soil. The use of sodium morrhuate is a "lucky strike," in that the

and regeneration in three weeks, provided there is no infection.

The osteomyelitis we have developed is a pan-osteitis, as distinguished from the local osteitis produced by bacterial inoculation of bone. The majority of bone infections seen in compound fractures appear to us as in the nature of an osteitis, and when a real osteomyelitis develops, it is probably due to a self-propagating thrombus arising at the site of fracture, as a result of neighboring soft-tissue infection. If this is true, the importance of *débridement* is self-evident in order to remove all potential sources of infected thrombi which may advance in the direction of the periosteal and subperiosteal vascular systems. This would be especially true in the region of the nutrient vessel to the shaft and its primary and secondary branches.

The experimental osteomyelitic picture exhibits an acute stage, characterized by local tumor, pain, redness and heat,

before, during and after development of the osteomyelitis, did not change the course of the infection or alter the x-ray



FIG. 7. A, experimentally induced osteomyelitis of right tibia of rabbit of fifty-two days' duration. Practically the entire shaft is involved. B, same rabbit as in 7A seventy-three days after the induction of osteomyelitis. Healing is well advanced, epiphysis is intact despite severe metaphyseal involvement.

without early x-ray findings, but developing into subacute and chronic stages with definite x-ray changes. The entire process takes about three weeks: the acute stage lasts about ten days; the subacute, the week following the acute, with a heavy involucrum in two to two and a half weeks, the chronic stage following the acute three weeks. The rapidity of the process may be accelerated by an excessive amount of sodium morrhuate, causing too much necrosis. The x-rays reveal destruction of bone, periosteal proliferation, sequestration, involucrum and abscess formation. In no instance did draining sinuses develop.

Sulfathiazole administered to rabbits

findings. Nor was the incidence of mortality affected. Even though the osteomyelitic picture did not vary under its use, it was suspected of debilitating the animals.

Results of chemotherapy by the enteral route in rabbits should be accepted with caution. Blood levels cannot be maintained nor absorption be regular, due to the herbivorous sac-like stomach of rabbits. Dogs might be more suitable for such experimentation.

In the sulfathiazole experiment one group of animals was fed 1 Gm. of sulfa drug in divided doses, daily. In another group the drug was withheld for purposes

of control. All of these animals afforded x-ray evidence of chronic osteomyelitis, but showed no draining sinuses. These

concentration, though carried out, proved unsatisfactory.

It has been suggested that the young



FIG. 8. Microphotograph showing metaphysis of rabbit's tibia thirty-four days following intrametaphyseal injection of .2 cc. of sodium morrhuate. Zone of necrosis (b) separates original provisional zone of calcification (a) from regenerated epiphyseal plate and osteoid columns (c). $\times 30$.

were all young rabbits. The same experiment should be repeated on adult rabbits.

While the drug apparently had no effect on the course of the osteomyelitis, the animals receiving it became quite debilitated, compared with the control group. Cultures from blood and bone yielded *Staphylococcus aureus*. The pus cultured from infected bones likewise always yielded *Staphylococcus aureus*. In most instances the blood culture was positive for the same organism. This was also true of the sulfathiazole-treated animals. A study of blood sulfathiazole

rabbits originally experimented upon, offered an osteomyelitic picture similar to that of children during their first year. Especially massive involvement and heavy periosteal reaction appear in both pictures. Also the hematogenous osteomyelitis of infants always presents a different problem from that seen in older children and adults. Infants usually overcome the infection under simple supportive therapy, and rarely show draining sinuses.

Bone formation in our rabbits was massive and large involucrums formed. To determine whether the osteomyelitic

course is different in old rabbits, further experimentation is being carried out. The rabbits now employed are adults with

introduced and a plaster cast applied. The result may disclose chronic osteomyelitis with draining sinuses. The controls



FIG. 9. Microphotograph showing metaphysis of rabbit's tibia indicating experimentally induced osteomyelitis of three weeks' duration. Zone (a) osteoid columns. Note necrosis and purulent exudate; zone (b) fibrous tissue; zone (c) living bone. $\times 65$.

closed epiphyses. They readily develop osteomyelitis. The course of the infection is as yet too recent for further report at this time. The infection has been successfully reproduced in dogs but not treated experimentally as yet. Valuable results are expected from these animals.

Beside those already indicated, many experimental problems in the treatment of osteomyelitis are now under way. One involved early operation upon the infected tibia before x-ray evidence was present. A window was made in the tibia for drainage; the inflammatory marrow was cultured and invariably yielded *Staphylococcus aureus*; a vaseline pack was

never developed any. If chronic osteomyelitis can be produced by early surgery, treatment of this type of osteomyelitis by further surgery, combined with sulfa drug and vaseline pack technics, will be attempted.

The excellent clinical reports of Hoyt and his associates on the nonsurgical treatment of acute osteomyelitis, may be possible to duplicate experimentally. They used both sulfathiazole and sulfadiazine, without surgery. Even frank, fluctuant, subcutaneous abscesses were not drained. None of their patients developed sinuses. How often does one see draining sinuses in unoperated osteomyelitis? Is it not true

that most of them are operated upon and that the combination of acute osteomyelitis plus surgery may account for many of the draining sinuses?

sulfathiazole therapy. Such an outcome depends on the fundamental basis in the development of an osteomyelitis: bone damage and infection. If the infection is

ETIOLOGY of OSTEOMYELITIS

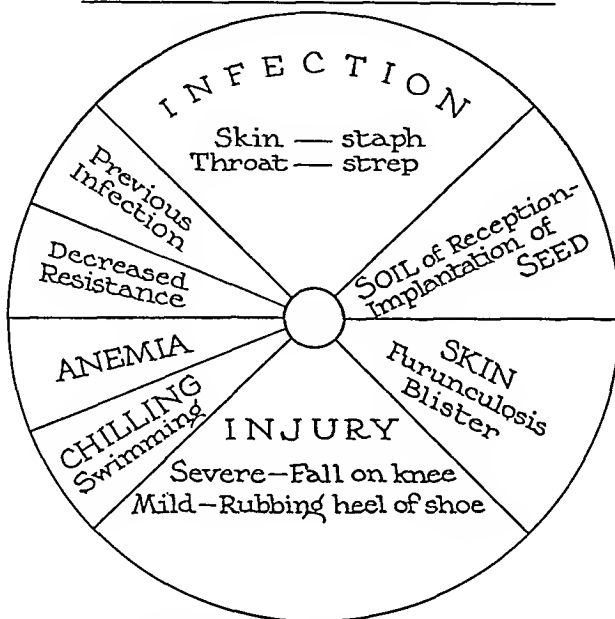


FIG. 10. Diagrammatic representation of the important etiological factors in human osteomyelitis.

Perhaps some animal other than the rabbit, which we believe cannot be adequately sulfa-drugged, is more tolerant and absorbs the drug, developing beneficial results comparable to those in man. If sulfatherapy is tolerated adequately by an animal, the course of experimental osteomyelitis will probably be modified. Even if the bone field has been prepared, osteomyelitis may not develop in an animal saturated with sulfathiazole.

At this point a fine opportunity is offered for comparison of results from operative and nonoperative methods. We may compare (1) patients with acute cases of the disease who have been operated upon but have had no sulfathiazole therapy, with (2) patients with acute cases of the disease who have had sulfathiazole therapy but no surgery. We should expect the comparison to show a greater percentage of chronic osteomyelitic cases with drainage sinuses from the first group: the acute cases, operated on, but receiving no

controlled, the bone may repair itself to a great degree and necrotic bone may be absorbed by osteoclastic activity and phagocytosis. Wilensky long ago stressed the point that surgery is often meddlesome and adds insult to injury. With the advent of sulfathiazole, the comment may be even more true. Certainly recent reports indicate that acute "osteos" do well if left alone, except for supportive measures and for chemotherapy.

The following program of experimental therapy is now being carried out by us on rabbits with open and with closed epiphyses. These animals show definite x-ray evidence of chronic osteomyelitis but have no draining sinuses.

1. The control animals have never had sulfathiazole nor been subjected to surgery. They have chronic osteomyelitis without draining sinuses, and will be permitted to live until the end comes naturally. X-rays will be made at regular intervals to observe the course of the osteomyelitic process.

2. Other rabbits have chronic osteomyelitis without sinuses but had been used in the sulfathiazole "before, during and after" experiment. The drug had not affected the course of the infection one way or the other. One Gm. of the drug had been given in daily feedings in divided doses. When the drug was stopped, these animals had had osteomyelitis on an average of eight weeks, but had been without the drug for about three weeks when this experiment was started. (*Staphylococcus aureus* culture from bone was positive at the time of the ensuing operations.)

Group 2 has been broken up into the following subgroups: (A) Resection of entire infected portion of tibia subperiosteally followed by primary suture of wound and plaster cast; (B) resection of entire infected tibia subperiosteally with sulfathiazole implantation into the periosteal tube and soft tissues, plus primary closure of the wound and a plaster cast; (C) saucerization of the tibia, plus vaseline pack and plaster cast (Orr); (D) saucerization of tibia, wound left open (without vaseline pack) and plaster cast; (E) saucerization of tibia, sulfathiazole implantation and wound left open without vaseline pack or plaster cast, and (F) controls: sulfathiazole animals without surgery.

Factual data on therapeutic results of the problem are not yet ready. The animals tolerate the casts; the wounds heal rapidly and some sinuses have formed. Many months of experimentation will be required before conclusive data are available.

The experimental animals exhibit constitutional symptoms and local manifestations. They have fever during the early stage, associated with anorexia and lethargy. Most of the rabbits have positive blood cultures. A "pseudoparalysis" of the legs is probably due to pain. The sedimentation rate and blood count studies for leucocytosis were not carried out carefully enough for clinical evaluation.

Within twenty-four to forty-eight hours, the injected leg appears markedly swollen. The bony outlines of the leg are decidedly

less sharp. The skin of the injected leg appears slightly hyperemic and warmer than the other leg. This applies to the morrhuate controls as well as to the infected animals. The morrhuate produces an irritative, aseptic inflammatory reaction; after the first week the morrhuate control animals quickly return to normal. The clinical picture continues in the infected animals.

The first week after the injection the animals seem somewhat lethargic, often have drooping ears and sit in their cages favoring the injected leg by raising it off the bottom of the cage. There is usually some loss of weight during the first week after the injection.

Heart-blood cultures taken forty-eight to seventy-two hours after injection of the leg with sodium morrhuate and *Staphylococcus aureus* are often positive for *Staphylococcus aureus*, becoming negative within ten days.

This coincides with observations in the literature on blood cultures in animals after injection of cultures (Koch and others). When our animals die and a positive culture is obtained from the blood, the early bacteremia has been superseded by a septicemia, with bacteria growing in the peripheral blood and not dependent on the feeding focus, i.e., the osteomyelitis. Could such animals be given effective chemotherapy and be kept alive, it would prove that fulminating osteomyelitis in the presence of a septicemia rather than a bacteremia should never be operated upon but should be given supportive treatment and chemotherapy. Our animals show the same purulent foci in all vital organs, especially the kidneys, as noted in human "osteos" of this type. The osteomyelitis appears to be unimportant in comparison with the septicemia, which is usually fatal.

Routine cultures are not taken, because an abscess results at the site of entrance of the needle into the heart of those animals having a positive blood culture.

When very young rabbits are used (2 pounds), there is a rise of one to four

degrees in body temperature during the first week. The temperature remains normal during the chronic stage of the osteomyelitis. Older rabbits exhibit no increase in body temperature. The average normal body temperature of rabbits is 101.5°F.

A large and important group of experiments can be performed to clarify the mechanism of osteomyelitis in compound fractures. (1) Produce a compound fracture of the femur or tibia. Apply virulent (for the animal species used) staphylococci locally to the wound depths. (2) Same as (1), but first strip the periosteum in the region of the nutrient artery, to cause a certain amount of bone necrosis. (3) Same as (1), but first attempt to localize and thrombose the nutrient artery, using sodium morrhuate. (4) Same as (1), but also produce an infected thrombus in a fair-sized neighboring vessel in muscle or fascia or an infection in the soft tissues which will secondarily give rise to a propagating infected thrombus.

The following questions remain to be clarified: Does the morrhuate act directly on the bone elements, or is vascular thrombosis an important factor in the aseptic necrosis? What is the smallest amount of morrhuate which, when injected, will lay the foundation for osteomyelitis after the addition of live bacteria, either intravenously or intrametaphyseally? Such information is very important to avoid using too much morrhuate. An excessive morrhuate action may account for the rapidity of the osteomyelitic process which we have seen in our animals. A minimal amount may permit a slower development, simulating more closely human osteomyelitis, and perhaps also cut down the mortality. How far does the morrhuate diffuse after injection, and how far does the aseptic necrosis extend, with varying degrees? We want to combine with the morrhuate a radiopaque substance either thorotrast or lipiodol, so that the action can be localized. It would then be possible to determine the extent of diffusion of the morrhuate in a roentgenogram. We tried

to do it with charcoal, but that involves the study of microscopic sections, which is a laborious task. Does one note the first microscopic changes following morrhuate injection in hours or days? What is the longest interval which may elapse between the morrhuate (injury) and bacterial injection (infection) in order to produce osteomyelitis? What happens to the experimental osteomyelitis if allowed to go indefinitely without sacrificing the animal? Does it go on to a chronic phase? Or does it heal? Does the infecting dose determine the subsequent course, or is the osteomyelitic once initiated self-propelling, regardless of whether the dose is minimal or maximum? What factors determine the death of the animals rather than their living and developing osteomyelitis? Do they concern dosage, virulence, lack of resistance generally? Will animals rendered sensitive to bacterial products, develop a more fulminating osteomyelitis, or will the process tend to localize because of a hypersensitivity reaction? Compare the tubercle of tuberculosis and the galloping pneumonic type. Further analysis of our present experimental work will answer many of these questions in due time. Other questions will be solved by future experiments.

If one may be permitted to speculate on the morrhuate phase of the work alone, there are ample analogies for experimental production of many clinical entities. Consider the possibilities of the aseptic necrosis problem with experimentation in the Legg-Calve-Perthes disease, osteochondritis and epiphyseal growth. One might also consider the production of osteoid-osteoma, bone tumors and degenerative joint diseases of the chronic arthritic type. The field of experimentation in osteomyelitis itself is vast and practically virgin.

In addition to those mentioned elsewhere, we received encouragement, assistance and guidance from Drs. Ludvig Hektoen, Edwin W. Ryerson, Hollis Potter, C. Howard Hatcher, Robert A. Arens and especially Dallas B. Phemister.

A NEW TREATMENT FOR ACUTE DILATATION OF THE STOMACH

EDWARD G. JOSEPH, M.D.

Attending Surgeon, Hadassah University Hospital
JERUSALEM, PALESTINE

THE prevalent opinion is that acute postoperative dilatation of the stomach generally follows upper abdominal surgery, and that it is very amenable to treatment. Such, however, is not the case. Acute dilatation of the stomach may follow almost any type of operation in any part of the body. All methods of treatment, hitherto advocated, may be unsuccessful and the condition may result in the death of the patient.

Thomas¹ reports two such deaths. In one case a male aged forty-one, had had a thoracoplasty and phrenicectomy. The postoperative course was uneventful until the fourth day, when the patient became dyspneic and cyanotic, developed a rapid and thready pulse and died that same day. At autopsy, the only finding of importance was acute dilatation of the stomach.

The second case was a male, aged twenty-six, on whom also thoracoplasty and phrenicectomy had been carried out. On the second postoperative day, the patient's abdomen became greatly distended. The patient developed marked dyspnea, cyanosis and a very rapid pulse and died in forty-eight hours. At autopsy, the only significant findings was acute dilatation of the stomach.

Johnson and Rabinowitch² report a death from acute dilatation of the stomach in a male, aged twenty-nine, who had been operated upon for Dupuytren's contracture. A plastic operation had been performed and the hand was sutured to the skin of the thigh.

On the third postoperative day the patient developed abdominal pains and vomiting. Vomiting continued for nine days. There was no improvement following

gastric lavage. Extreme toxemia developed, incessant vomiting continued, and the patient died on the tenth day.

At autopsy, the stomach and duodenum were found to be dilated and there appeared to be an obstruction at the third part of the duodenum, where it is crossed by the fold of mesentery which contains the superior mesenteric artery.

The intestine below the point of obstruction was contracted and empty. By lifting the mesentery overlying the third portion of the duodenum, the obstruction was partially released and some of the duodenal content passed into the jejunum.

Lorenzetti³ advocates jejunostomy for the treatment of acute postoperative dilatation of the stomach. The cases above cited and the surgical treatment suggested by Lorenzetti³ indicate the following: (1) Acute dilatation of the stomach may follow operations carried out on any part of the body. (2) The generally accepted method of treatment, namely, gastric lavage may be completely ineffective. (3) Jejunostomy has been advocated for the relief of this dangerous condition. (4) Postoperative acute dilatation of the stomach is a dangerous complication and may result in the death of the patient.

SYMPTOMS

In acute dilatation of the stomach the epigastrium may be distended while the lower part of the abdomen remains soft and flat. Vomiting is usually intermittent but persistent, and enormous quantities of fluid may be regurgitated.^{4,5} The vomitus consists of green or brownish-black fluid which is generally odorless and neutral in reaction.

The vomitus contains little or no free hydrochloric acid and nearly always contains bile, and other digestive secretions from the upper part of the alimentary tract.

Nondistention of the jejunum and ileum, normal intestinal peristaltic activity and normal bowel movements aid in differentiating acute dilatation of the stomach from paralytic ileus.

The blood urea values are always high and persistent vomiting results in a sharp lowering of the blood chlorides.

ETIOLOGY

Carlson and Luckhardt⁶ and Alvarez⁷ have shown that the alimentary tract possesses a peripheral automaticity which is similar to that of the heart. Section of the vagus nerves or of the sympathetic branches to the heart does not result in paralysis of the cardiac musculatures. Similarly, section of the extrinsic nerves of the stomach does not produce gastric paralysis.

Dragstedt and his co-workers^{4,5} have repeatedly sectioned both vagi, as well as both vagi and splanchnics in dogs, without producing any evidence of gastrointestinal paralysis. They state that it has been clearly demonstrated that a primary occlusion of the transverse portion of the duodenum by the superior mesenteric vessels was responsible for acute dilatation of the stomach. They claim that it can be easily demonstrated experimentally that a stenosis of the duodenum results in a gradual dilatation and hypertrophy of the part above the obstruction. Acute dilatation of the stomach, however, has never been reported following experimental stenosis of the duodenum.

Novak⁸ has pointed out that acute dilatation of the stomach has been described in the relatively few cases of high intestinal obstruction, from various causes, that have been reported in the literature. The occurrence of acute dilatation of the stomach during the course of an operation, with the patient in the Trendelenburg position, would seem to rule out the possibility

that duodenal obstruction plays any rôle in the production of acute dilatation of the stomach.

Dragstedt and his coworkers^{4,5} believe that it is far more probable that acute dilatation of the stomach following surgical operations or manipulations, including extensive stimulations of either somatic or visceral sensory nerves, is due to reflex inhibitions of the stomach through the efferent fibers in the vagi and splanchnic nerves. The peripheral gastric motor mechanism is depressed at the same time by the anesthesia, debilitating disease, or the malnutrition of the patient. They believe that the functional and anatomic conditions present in acute dilatation of the stomach prevent the passage of the gastric and pancreatic juices and of the bile from passing into the lower intestine, so that these fluids accumulate in the dilated stomach.

The evidence suggests that a primary or acute gastric dilatation, reflex in origin, occurs either during the course of an extensive operation or immediately afterward. This is followed by a secondary mechanical occlusion of the inferior horizontal portion of the duodenum, either by direct pressure of the dilated stomach against the duodenum or by a secondary arteriomesenteric compression resulting from the downward pressure of the dilated stomach which forces the small intestines into the pelvis.

TREATMENT

The commonly accepted form of treatment for acute dilatation of the stomach is to insert a tube into the stomach either through the nose or directly through the mouth. The stomach is then thoroughly and frequently irrigated through this tube. At the same time, to counteract the loss in blood chlorides, saline and glucose are given in large quantities intravenously.

It is important to remember, however, that the above mentioned procedures may prove to be completely ineffective in some cases, and that the patient may continue to vomit, go rapidly downhill, and die.

Four years ago the writer introduced a new form of treatment on the surgical service of the Hadassah Hospital in Jerusalem, that has saved, without question in the writer's mind, the lives of six of his patients.

Clinical observations of patients on the surgical wards of the Hadassah Hospital extending over a period of many years, has convinced the writer that the surgical complication of acute dilatation of the stomach probably was not caused by ether or spinal anesthesia, or that it resulted from any specific operation, or from operation on any specific part of the body.

The writer observed that all the patients who developed acute dilatation of the stomach had only one common factor, namely, the enforced confinement to bed following the operative procedure. It seemed to make no difference whether these patients had been kept in a horizontal position or had been propped up in bed. The one common and determining factor was the enforced confinement to bed.

It seemed logical, therefore, to reverse this state of affairs, and to force these patients to stand upright, and to aid them in taking a few steps. It was fully realized that a heroic method of treatment of seriously ill and debilitated patients was being proposed. However, it seemed justified in an effort to save life.

On paper the procedure sounds simple. In practice, however, it is not an easy task. The patient is on the verge of exhaustion from his long continued vomiting. He generally can hardly lift a limb or move his head, and is completely helpless. It requires, therefore, the aid of three strong men to lift the patient gently from his bed, to hold him upright on the floor, and to aid him in taking a few steps. The writer is well aware that the advocacy of this form of treatment sounds cruel and unorthodox. However, uncontrolled acute dilatation of the stomach with persistent vomiting, results in almost certain death of the patient, and the writer's experience has convinced him that the treatment advocated

offers the patient probably his one chance for survival.

The results, once the patient is placed in the erect position, are extremely startling. The patient will experience a gurgling sensation in the throat and will belch. He will, generally, ask for a drink and will at once be able to swallow half a cupful of water without nausea. After being supported in the erect position for ten minutes and after aiding him in taking a few steps, the patient is gently laid down on his bed. In two or three hours the treatment is repeated, if necessary. Usually, after this, the vomiting stops and the patient begins to feel much more comfortable.

CASE REPORTS

CASE I. A male, aged sixty-five, in good physical condition had had a suprapubic cystostomy under low spinal anesthesia. His blood urea value was within normal limits. Following the operation, he began to vomit greenish colored fluid in large quantities. A diagnosis of acute dilatation of the stomach was made. A stomach tube was then passed through the nose and the stomach was washed out thoroughly at half hour intervals. The patient's condition, however, did not improve. He could not retain any food or water. In accordance with the customary procedure in such cases he was given intravenously several liters daily of normal saline and glucose. In spite of this the patient's blood urea began to rise. Vomiting of large quantities of greenish-black fluid continued for fourteen days. It was obvious clinically that the patient would die, unless his vomiting could be controlled.

In desperation, and since it seemed very unlikely that the operation had had anything to do with the development of the acute dilatation of the stomach the writer decided to force the patient to get out of bed and walk.

Notwithstanding the patient's bitter protests, he was made to stand up and was forced to take a few steps. He at once regurgitated some gas, and asked for a drink, which he kept down. From that moment vomiting stopped, and the patient made an uneventful recovery.

CASE II. A middle aged, obese, male had had a cholecystectomy. Following the operation the patient began to vomit and, in spite of the usual treatment, vomiting continued for six

days. On the seventh day, when the patient's condition became critical, he was lifted out of bed, was made to stand up and was encouraged to take a few steps. From that moment his condition improved.

CASE III. A young male with a duodenal ulcer had had a Hofmeister-Pólya gastrectomy performed under spinal anesthesia. The stoma did not function. Consequently an anterior gastrojejunostomy with an extero-enterostomy was performed several days later. The patient developed postoperative acute dilatation of the stomach which failed to respond to the usual treatment. On the fifth postoperative day the patient's condition became extremely critical and it was obvious that something drastic had to be done to save the patient's life. He was consequently lifted out of bed and put into the erect position. Again the above described phenomenon occurred. The patient eructated gas freely, and drank some fluid which he was able to retain. Vomiting stopped, and the patient made a splendid recovery.

CASE IV. A male patient had had a resection of a large segment of the ileum, which became gangrenous following a volvulus. An acute dilatation of the stomach developed postoperatively, which was treated unsuccessfully with the usual methods for several days. On the eighth day, with the patient in an extremely weakened and critical condition, he was lifted out of bed and made to stand up. The result was very spectacular. Vomiting stopped abruptly and the patient made an uneventful convalescence.

CASE V. A male, sixty-eight years old, who had a large gastric ulcer, had an anterior gastrectomy performed by the Hofmeister-Pólya technic, under continuous spinal anesthesia. There was a normal postoperative recovery until the tenth day. On the following day, however, the patient began to vomit incessantly. Gastric lavage failed to effect the vomiting in the slightest degree, and the patient's condition rapidly deteriorated. It was then decided to lift the patient out of bed and to make him stand up. The procedure was carried out and the patient almost immediately belched. His subsequent recovery was uneventful.

CASE VI. A young woman who had had a cholecystectomy and appendectomy suddenly began to vomit on the fifth postoperative day. She vomited huge quantities of blackish fluid for three days. The patient could not tolerate

passage of a regular stomach tube through the mouth and an irrigating tube could not be passed through the nose. The patient's condition became very critical and it was decided to lift her out of bed and to make her stand up. As soon as this was done the patient's nausea and vomiting ceased abruptly. She immediately began to retain fluids and made an uneventful recovery.

SUMMARY

1. Acute dilatation of the stomach is a postoperative complication which, generally, is easily controlled.

2. Occasional cases of acute dilatation of the stomach occur which do not respond to the usual treatment by gastric lavage and intravenous injections of glucose and saline. In these cases the incessant and uncontrolled vomiting causes the death of the patient from dehydration and toxemia.

3. The postoperative complication of acute dilatation of the stomach does not seem to be caused by ether anesthesia or by spinal anesthesia, and may follow any type of operation, in any part of the body.

4. The one common factor in the cases of acute dilatation of the stomach, observed by the writer, was the enforced confinement to bed following an operative procedure.

5. A new treatment is described and advocated in cases of acute postoperative dilatation of the stomach, which cannot be controlled by the usual and orthodox forms of treatment.

6. The treatment advocated consists of gently lifting the patient out of bed and supporting him in an erect position for approximately ten minutes. He should be encouraged and aided in taking a few steps. This maneuver should be repeated after a two or three hour interval in those cases that do not respond satisfactorily or completely to the first attempt.

7. This new form of treatment has been effective in saving the lives of all six of the writer's cases in which death seemed to be imminent from the dehydration and toxemia caused by the incessant and uncontrolled vomiting of postoperative acute dilatation of the stomach.

REFERENCES

1. THOMAS, C. A. Acute dilatation of the stomach following left sided phrenic paralysis and thoracoplasty. *J. Thoracic Surg.*, 5: 507, 1936.
2. JOHNSON, J. G. W. and ROBINOWITCH, I. M. Clinical and biological findings in two cases of acute dilatation of the stomach. *Canad. M. A. J.*, 22: 811, 1930.
3. LORENZETTI, C. Treatment of acute post operative dilatation of the stomach by jejunostomy. *Atid. d. Sec. Ital. die. Chir.*, 36: 98, 1930.
4. DRAGSTEDT, L. R., MONTGOMERY, M. L., EDIS, J. G. and MATHEWS, W. B. Pathogenesis of acute dilatation of the stomach. *Surg., Gynec. & Obst.*, 52: 1075, 1931.
5. DRAGSTEDT, L. R. and DRAGSTEDT, C. A. Acute dilatation of the stomach. *J. A. M. A.*, 79: 612, 1922.
6. CARLSON, A. J. and LUCKHARDT, A. B. Vagal control of the oesophagus. *Am. J. Physiol.*, 56: 299, 1921.
7. ALVAREZ, W. C. An Introduction to Gastroenterology. New York, 1939. Paul B. Hoeber.
8. NOVAK, J. Acute postoperative dilatation of the stomach. *J. A. M. A.*, 77: 81, 1921.



COMPLETE abortion is evidenced by the extrusion of an intact product of conception or by the prompt cessation of symptoms and the normal progress of involut.on. The after-treatment is that of the puerperium.

THE DANGERS OF BORIC ACID*

ITS USE AS AN IRRIGANT AND REPORT OF A CASE

CHARLES A. ROSS, M.D. AND JOHN F. CONWAY, M.D.†

GALESBURG, ILLINOIS

INTOXICATION with boric acid and other borate compounds is a constant threat which physicians and laymen rarely appreciate. Boric acid is an insidious, carelessly used, poisonous drug with power of fatal poisoning. To illustrate the seldom appreciated dangers a survey was made of the medical men in a typical midwestern community. Of thirty doctors questioned twenty had never heard of boric intoxication, nine knew that boric acid could cause poisoning when ingested, one had seen a case of boric poisoning, and none knew that boric acid could be absorbed in fatal quantities when used as an irrigant in body cavities.

Boric acid compounds are widely used with impunity by both medical and lay groups for a great number of purposes. (Table 1.) The eyes of almost every newborn infant are cleansed with boric acid in hospitals and homes in spite of such catastrophies as the six infants in a Chicago hospital^{13,20} who died of accidental boric acid ingestion in 1927. It is a common practice to use boric acid as an antiseptic for rubber nipples and to cleanse the nipples of nursing mothers. Even in the literature accompanying a popular brand rubber nipples boric acid is recommended for purposes of sterilization. Yet Aikman¹ lists a case of boric acid poisoning in a two-day old infant due to nursing its mother's breast after boric acid had been used as a nipple wash. Boric acid and borate compounds are usually dispensed without a poison label and may be found upon the medicine shelf of any home. Nevertheless, Potter²⁷ reports a fatality from the accidental ingestion of an ounce of borax by a

sixty-six-year old adult. We have never seen any hospital institution in which special care was taken in labeling and storing boric acid solutions. Notwithstanding, serious intoxication from the accidental administration of such solutions intravenously and by hypodermoclysis has occurred.^{8,10,15,26} As Max Trumper³⁰ so well states: "The common use of boric acid in medicine as a mild antiseptic in the nose, throat, eye, and other cavities has served to create such an impression of its harmlessness that its potential danger as a poison has been neglected."

The harmful effects of the use of boric acid preparations as food preservatives have been so well established that such practice is illegal in the United States, France, Germany, Holland, Italy, Spain, and Great Britain.^{13,20} For many years this procedure was debated until an extensive literature on both sides of the argument developed, particularly in Great Britain. During this controversy it was well established that boric acid could produce harm when ingested in large quantities in a single dose or in small quantities over an extended period of time.^{11,20,26,27,29}

That boric acid may be absorbed from body cavities in sufficient quantities to produce fatal poisoning is little known. Hence, it is widely used without precaution as an irrigant of the pleural cavity, urinary bladder, infected wounds, conjunctival sac, vagina, mouth, sinuses and colon.

PHARMACOLOGY

Boric or boracic acid occurs either as white, translucent scales or as a powder with a slight acid reaction. It is freely

* From the Gunning Clinic. † Dr. Ross is now on active duty in the U. S. Navy and Dr. Conway is with the U. S. Army Air Corps.

soluble in boiling water, alcohol and glycerin. It is commonly used as its sodium salt, borax or sodium borate, and as the

preparations are the glycerite of boric glycerin composed of 310 parts boric acid and 690 parts of glycerin and the boric acid

TABLE I
SUMMARY OF USES OF BORATES

	Uses	Methods and Preparations Employed	
Medical Uses in Hospital and Office	Infected wounds ⁷ Burns ¹⁸ Ulcers ¹⁵ Erysipelas Eczema ²⁹ Ichthyosis Osteomyelitis Lymphangitis ²⁹ Cellulitis ³¹	Hot compresses Topical applications Topical applications Topical applications Topical applications Topical applications Packs Moist packs & dressings Moist packs & dressings	Saturated boric acid solution Boric solution & crystals Boric acid ointment Boric acid powder In glycerole of starch Borate of glycerin Saturated boric acid solution Saturated boric acid solution Ochsner solution
	Peritonitis ¹⁵ Diarrhea ²³ Dysentery Colitis ²³ Constipation ³	Enemata Colonic irrigations Rectal irrigations Rectal irrigations Rectal irrigations	Saturated boric acid solution Saturated boric acid solution Saturated boric acid solution Boric acid solution Boric acid solution
	Trichomonas vaginalis Non-specific leukorrhea ¹⁶ Specific vaginal infections Monilia	Douches Cervical caps Powder insufflators Douches	Saturated boric acid solution Boric acid powder Boric acid powder Boric acid powder
	Obesity ²⁹ Uterine hemorrhage ²⁹ Thrush lesions of mouth ¹⁹ Epilepsy ²³ Locomotor ataxia Paralysis agitans	Orally Orally Orally Orally Orally Orally	Boric acid crystals and powder Sodium borate Honey and borax Sodium borate Sodium borate Sodium borate
	Urinary bladder infections and urinary retention ^{22 10} Empyema cavities ²³	Irrigations Irrigations	Saturated boric acid solution Saturated boric acid solution
	Eye infections, infants and adults (also medically) ²⁹ Mother's nipples ¹ Aphthous stomatitis ²⁹ Pharyngitis Laryngitis Rubber nipples Rhinitis	Irrigations Wash Mouth wash and gargle Orally Orally Antiseptic Irrigations	Saturated boric acid solution Saturated boric acid solution Borated glycerin Honey and borax Boric acid solution Saturated boric acid solution Borated glycerin
Commercial Uses	Food preservatives (illegal many countries) Talcum powder Douche powder Mouth wash Antiseptics Contraceptive jellies Other Commercial Uses	1/20 per cent to 4 per cent adulteration Many formulas Many formulas Many formulas Many formulas Many formulas Many formulas	Boric acid crystals Boric acid powder Boric acid powder Boric acid powder Boric acid powder Boric acid crystals Boric acid and sod. borate

acid in saturated solutions which are 4 or 5 per cent strength depending upon the degree of saturation which varies with the temperature of the solvent. Popular official

ointment containing 10 per cent boric acid.

Boric acid and sodium borate have questionable antiseptic action.¹¹ In 2.5 per cent

solutions almost all forms of bacteria stop growing but are not destroyed, even the delicate anthrax being capable of further growth after exposure of 4 per cent solutions for twenty-four hours. Bastedo² states that Bernstein demonstrated as early as 1910 that boric acid had power to check the growth of yeasts and harmless saprophytes but had only slight effect upon typhoid and other pathogens.

Buzza and Cerratola⁹ reported the toxic dose of boric acid to be 4 Gm. per kilo in rabbits and said that their animals died in twelve to twenty-four hours from central paralysis and gastrointestinal irritation. They, also, said that Gaucher found the toxic dose in guinea pigs to be 1 Gm. per kilo. Negri²⁴ worked out the minimal lethal dose of boric acid in rabbits to be 0.043 Gm. per kilogram.

In the adult human the toxic dose has never been accurately determined but Gissel¹⁵ states that 15 to 30 Gm. are maximal doses. In an unusual case of accidental boric acid poisoning¹⁹ a forty-two year old white woman received 600 cc. of a 2.5 per cent solution of boric acid in 10 per cent dextrose (or 15 Gm., the oft-quoted minimal adult dose) intravenously. The patient was only mildly toxic and recovered in ten days. Here the rapid renal excretion of boric acid in eighty hours seems to have been a favorable factor. McNally and Rust²⁰ found 1 to 3 Gm. in infants to be the minimal lethal dose most often mentioned in the literature and reported the autopsies of six newborn infants who died after the accidental ingestion of 3 to 6 Gm. of boric acid per infant.

PATHOLOGIC PHYSIOLOGY

There have been interesting experiences with the local absorption of boric acid from wounds and body cavities. Kahlenberg¹⁷ reported that boric acid, when applied to the unbroken, living, human skin, was the only substance of many tried which appeared in the urine in appreciable quantities. It was found in the urine five minutes

after the feet were immersed in boric acid solution.

Sajons and Hundley²⁶ refer to the separate experiments of Hoffman and of Puppe. Strong fresh frogs were placed with the lower part of their bodies hanging in $\frac{1}{2}$ per cent boric acid solution. The portions of the skin exposed to boric acid developed blisters and epithelial exfoliation. In dogs, whose food contained 2.5 per cent of boric acid, postmortem examination revealed necrotic patches of the stomach and intestinal mucosae.

In Dopfer's case¹² enough boric acid was absorbed from a burn "measuring 13 centimeters" to produce death in three days. Gissel¹⁵ says that Lewin reported several cases in which single applications of boric acid for bladder, rectal, and pleural cavity irrigations caused an erythematous rash. Gissel himself reports a case in which boric acid ointment applied to extensive burns resulted fatally. He believes that healthy granulations in a wound might protect against the absorption of boric preparations. Maguire¹⁸ used hot boric fomentations on a leg wound in a twenty-three-year old female in whom he believed fatal intoxications resulted. As far back as 1899, Tillman²³ reported that Molodenkow saw two cases of vomiting, erythema, and eventual death after boric acid in 5 per cent solution had been used in washing out the pleural cavity in one instance and a lumbar abscess in another. In another case²⁸ rectal irrigations for dysentery were shortly followed by a bromide-like rash. In Table 11 we have summarized the salient facts in cases of boric acid and borate intoxications.

Having seen that boric applied locally may cause generalized symptoms it is of interest to note the pathological status in fatal cases. McNally and Rust²⁰ found that the reported lethal results may be divided into three classes: (1) those in which there was a chemical examination with pathologic and autopsy date; (2) those in which a chemical examination was not made but in which there were histologic observations; and (3) those in which death was due to a

known source of boric acid. Apparently in Class 3 pathologic and autopsy data are lacking. They reported six cases in infants with chemical data indicating that the brain and liver accumulated the higher percentages of boric acid, that is, 0.210 per cent and 0.182 per cent, respectively. The only other case with chemical analysis of organs is that reported by Bazin³ in a fifteen-year old male whose "generalized peritonitis" was treated with boric acid enemas. Here the chemical examination was limited to the "intestinal tube" and revealed no borates.

It is to be noted that pathological examination of certain organs are repeatedly mentioned in the literature. The brain and liver are mentioned most frequently and are described as either edematous or congested. The gastrointestinal tract is described as inflamed or congested occasionally even in cases in which the borate has not been ingested. Petechial hemorrhages and congestion are mentioned in association with the renal disturbance. In at least three instances, inflammation or hydrops of the pericardium and pleura were noted. (Table II.)

SYMPTOMATOLOGY

Certain symptoms and findings are constantly present in cases in which intoxication has been due to a known source of borate regardless of the route of administration. A typical clinical picture usually starts with nausea and mild shock followed in a few hours by diarrhea, vomiting, and more profound shock, associated with a fall in temperature and the appearance of an erythematous rash. This rash resembles the skin manifestations of scarlet fever. If the patient survives twenty-four to forty-eight hours there is frequently desquamation not only of the areas occupied by the rash but also of the mucous membranes. The skin lesions are distributed over the entire body and in certain cases the finger and toe nails have been discolored.⁶ In fatal cases, the terminal picture is one of depression

and shock occurring as late as three to five days after the borates have been withdrawn.^{5,7,12,15}

CASE REPORT

A white male child, three years of age, was admitted to St. Mary's Hospital on February 4, 1942, with dyspnea, pain in the left chest, cough, and fever present about thirty-six hours. The family history was irrelevant except that a younger sister was having a severe upper respiratory infection. The past history revealed no previous illness of significance. Examination showed a poorly nourished, pale child acutely ill with a rectal temperature of 103.4°F. The pulse was 120 and the respirations 45. There were a few small, firm cervical lymph glands palpable. The child was dyspneic with limitation of respiratory movements in the left thorax. Percussion revealed dullness over the entire left lung. Moist, râles were heard in the left lung, but, for the most part, the breath sounds were suppressed. The abdomen was tense and not tender or distended. The fingernails had a bluish tinge.

The red blood count was 3,720,000 and the hemoglobin was 11 Gm. by the Sahli method. The white blood count was 34,200 with the differential count showing polymorphonuclear cells 86 per cent, lymphocytes 8 per cent and monocytes 5 per cent. The urine had a specific gravity of 1.011, a hydrogen ion concentration of 5.9 and showed a trace of sugar and albumin. The centrifuged urine sediment contained a few Gram-positive cocci. No sputum was obtained for typing because a sulfa drug had been used before admission to the hospital. An x-ray film of the chest revealed pneumonic infiltration of the entire left lung.

The patient was placed on a pneumonia routine. Sulfadiazine was administered in doses of ½ Gm. every three hours and regulated so that the daily blood levels were never lower than 8.5 mg. per cent. Five per cent dextrose in Ringer's solution was administered intravenously together with 25 cc. of 50 per cent dextrose twice daily. The patient showed slight improvement the second hospital day. He was able to take fluids orally. Cevitamic acid 100 mg., and ten drops of a cod liver concentrate containing vitamins A and D were given daily. The rectal temperature was 103.6°F. The blood picture and the chest findings were the same.

TABLE II
ANALYSIS OF REPORTED CASES OF INTOXICATION

Author Date Reported Age, Sex	Preparation and Amount of Borate	Method of Administration	Symptoms and Findings	Autopsy Data	Re- sult
Brose ⁷ 1883 31 yrs.	Powdered with b. a. powder for 5 days.	Leg sore.	Diarrhea. Weak- ness. Hema- temesis.	Congestion of stomach and intestines. Enlarged liver and spleen.	Died.
Molodenkow ²³ 1899 (2 cases) Ages unknown.	5 per cent b. a. sol. Irrig. with "15 kilo. 1 hr. at a time."	Pleural cavity. Lumbar abscess.	Vomiting. Ery- thema of face.	None.	Both died.
Best ⁸ 1903 Adult, male.	6 oz. b. a. powder.	In wound follow- ing exsection of inguinal glands.	Vomiting. Pap- ular rash. Weak pulse. Slight fever.	None.	Died.
Dopfer ¹² 1905 2 yrs.	B. a. ointment.	13 cm. burn of skin.	Searlatiniiform rash. "Head symptoms." Petechiae.	None.	Died.
McWalter ²¹ 1907 2 mos.	Borax and honey, 3-16 gm. boxes.	To thrush lesion in mouth.	Erythematous rash. Red lips. Vomiting and diarrhea.		Lived.
Sanders ²⁸ 1912.	B. a. solution.	Rectal irrigation for dysentery.	Bromide rash. Feeble pulse. Delirium.		Lived.
Wilson ³² 1915 7 wks. 6 days.	90 cc. saturated b. a. sol.	Accidental inges- tion.	Diarrhea. Vomit- ing. Miliary rash, later peeled.		Lived.
Maquire ¹⁸ 1916 23 yrs. Female.	B. a. fomenta- tions.	Traumatic wound of leg.	Headache. Mac- ulopapular rash. Vomiting.	None.	Died.
Forsyth ¹⁴ 1919 8 mos.	7.5 to 10 grains b. a. daily in milk.	Ingested.	None given.		Lived.
Potter ²⁷ 1921 66 yrs., Male.	Borax, 1 oz.	Ingested.	Epigastric cramps. Cyanosis. Choking.	Chemical analysis of stomach contents revealed 1.5 oz. borax. Autopsy: "Nothing abnor- mal."	Died.
Bazin ³ 1924 15 yrs.	6 tsps. b. a. in 6 cups water b.i.d. for 5-6 days.	Enemata.	Vomiting. Red skin rash. Stupor. Rapid pulse. Coma. Temp. 101°F. No bo- rates found in blood.	Chemical examination of "blood and intestinal tube" negative for borates. Injec- tion mesenteric blood vessels. Marked postmortem changes all organs. Congestion of kidneys.	Died.
Birch ⁶ 1928 18 days.	1.5 drams honey and borax—1 dose.	Ingestion for thrush.	Wasting. Uncon- scious. Rectal Temp. 96°F. Lips and nails bright red. Stools "cooked spinach" ap- pearance.	Congestion of liver and kid- neys with spots of hemor- rhage under capsule. Muscles and skin pink. Honey-like substance in stomach.	Died.
McNally & Rust ²⁰ 1928 (6 cases) Newborn inf.	3-6 grams total dose per infant. (Average Wt. 7#)	Ingestion.	None given.	Chemical analysis of chief organs showed brain and liver to have most boric acid present.	All died.

TABLE II. (Continued)

Author Date Reported Age, Sex	Preparation and Amount of Borate	Method of Administration	Symptoms and Findings	Autopsy Data	Re- sult
Aikman ¹ 1930 2 days.	Not given.	Nursing mother's nipples which had been cleansed with b. a.	None given.	None given.	Died.
Cushing, quoted by Gissel ¹⁵ 1933.	1 liter of 4 per cent b. a. sol.	Subcutaneously.	Edema of eyes. Albumin and W. B. C. in urine. Suppression of urine.	Acute parenchymatous de- generation of liver. Edema of brain. "Hydrothorax and hydropericarditis." Pylone- nephritis.	Died.
Schywser, quoted by Gissel ¹⁵ 1933.	15 grams of b. a.	Not given.	Anuria. Diarrhea. Colic. Collapse.	Acute degeneration of kidneys and liver. Inflammation of G. I. tract.	Died.
Gissel ¹⁵ 1935 4 yrs. Female.	B. a. ointment 30 60 grams.	Applied to band- ages to burn areas of skin.	Eyes red and swollen (in 2 hrs. after appli- cation). Vomit- ing. Diarrhea. Burned areas became leathery. Large quantities of b. a. in urine.	Fatty degeneration of kidneys and liver. Bronchopneumonia. Inflam- mation of epicardium and lower esophagus.	Died.
Brown, Brown and Murphy ⁸ 1936 45 yrs. Female.	1 liter, 2 per cent b. a. sol.	Subcutaneously.	No generalized symptoms. Albumin and casts in urine. B. a. in urine 4 days.		Lived.
McIntyre and Burke ¹⁹ 1937 42 yrs. Female.	600 cc. 2.5 per cent b. a. sol.	Intravenously.	Nausea. Flush- ing. Vomited once. All b. a. excreted after 8 hrs.		Lived.
Peyton and Green ²⁶ 1941 Youth. Male.	28 grams b. a.	Subcutaneously.	Erythema entire body with des- quamation. Dry cough. Disten- tion. Nausea. Vomit- ing. Sore-throat. Colon bacillus pyelonephritis.		Lived.
Authors' case 1942 3 yrs. Male.	Approximately 4 liters saturated b. a. sol.	Constant irriga- tion of pleural cavity.	Shock. Diarrhea. Vomiting. Cya- nosis. Erythe- matous rash with desquama- tion. Rectal temp. 101°F. to 103°F. B. a. in stomach contents.	Hydropericardium. Hydrops ascites. Fatty degeneration of liver. Degeneration of kid- ney. Brain edema. Increased amounts of b. a. in brain and liver.	Died.

Total number of cases—27

Mortality—74.07 per cent

On the fifth day the clinical picture remained unchanged. An x-ray of the chest revealed the left lung still to be consolidated but the right heart border was shifted slightly to the right.

By the eighth day the child was eating well. The blood picture was unchanged and the temperature was 100°F. Another roentgenogram upon the fourteenth day revealed no change in the left lung field with the mediastinal structures shifted to the right thorax so that the right heart border was at the right midclavicular line. The temperature had risen suddenly to 102°F. Thoracentesis gave a purulent fluid from which nonhemolytic streptococci were cultured.

The next day closed drainage of the left pleural cavity with a rubber catheter attached to an apparatus⁴ arranged for continuous irrigation with saturated boric acid solution (4 to 5 per cent) was begun; the patient received approximately four liters in twenty-four hours. The next day the child began to vomit and passed a bulky stool. By the end of forty-eight hours, he was drowsy and having continuous emesis and diarrhea. The red blood cells were 3,550,000, the hemoglobin was 11 Gm., the white blood cells were 13,600 and the differential count showed 74 per cent polymorphonuclear cells, 25 per cent lymphocytes, and 1 per cent basophiles.

On the morning of the eighteenth hospital day and seventy-two hours after the boric acid irrigations had been started, the patient was found in profound shock, the rectal temperature was 101.2°F., the radial pulse was imperceptible, and the skin was cold and clammy with cyanosis of the fingernails and lips. The neck, thorax and extremities were covered with an erythematous rash which was sharply demarcated at the base of the fingers and toes and at the edge of the mandible. The boric acid solution was replaced by normal saline as an irrigant. External heat and an intravenous transfusion of 250 cc. of citrated blood helped the shock but the vomiting and diarrhea continued.

The next morning the child was unconscious. The rectal temperature was 103°F., the pulse 108 and the respirations 40. Necrotic patches were found all over the body areas where the rash had been present the day before and in the mouth and throat. There was no favorable response to a half liter of blood plasma or nasal oxygen. The stomach contents gave a

strongly positive turmeric acid paper test for boric acid. This same test was negative on the urine. The blood creatinine was 5.0 mg. per cent. The boy expired at 6 P.M. of the nineteenth hospital day, four days after the boric acid solution had been introduced into the pleural cavity and one day after it has been discontinued.

Dr. E. J. Kraus of Peoria, Illinois did the autopsy and rendered a pathological report from which we quote as follows:

"Anatomical Diagnosis:

"1. Empyema of the left pleural cavity drained by an incision in the posterior axillary line.

"2. Extensive atelectasis of the left lung.

"3. Partial atelectasis of the right lung.

"4. Degeneration of the myocardium and dilatation of the left ventricle.

"5. Hydropericardium, hydrops ascites and edema of the mesentery and retroperitoneal tissue.

"6. Central fatty degeneration of the liver.

"7. Moderate acute splenic tumor.

"8. Degeneration of the kidney.

"9. Edema and diminution of lipoid of the adrenal cortex.

"10. Edema of the brain.

"11. Cyst in the choroid plexus.

"12. Extensive erythema of the skin with extensive exfoliation.

"Gross Pathology. The skin was greatly altered by an erythema which, especially in the face, on the neck and back, had led to widespread separation of the stratum corneum peeled off in large shreds.

"On opening the skull the meninges were found tense and the leptomeninges hyperemic. The brain appeared swollen, heavy, the gyri slightly flattened. The blood on the cut surface, which showed a striking luster, spread quickly. The gray matter was greyish pink. The ventricles were normally wide. There was a cyst in the plexus choriodeus of the right lateral ventricle the size of a pea. The sinuses of the dura mater were negative.

"The pleural cavity on the left side was for the greatest part converted into an empyema lined by a yellow fibrino-purulent pseudomembrane which was easily stripped off. The empyema extended from the diaphragm almost up to the apex of the upper lobe. The left lung, especially the lower lobe, appeared mostly atelectatic, dark red and firm in consistency. The right lung likewise appeared darker red than usual but for the most part was air con-

taining except the posterior portion of the upper and lower lobe. The pleura did not show any changes. The tracheal and bronchial mucosae appeared reddened.

"In the pericardial sac there was a moderate amount of a clear yellowish fluid. The heart was enlarged due to evident dilatation of the left ventricle. The myocardium was pale red, flabby, and softer in consistency than normal. The valves, aorta, and pulmonary artery were negative.

"In the abdominal cavity there was a moderate amount of ascites. The stomach was slightly distended but was not opened because of a later chemical examination of its contents. The duodenum and small intestines were distended and filled with yellow liquid. The mucosa appeared slightly swollen and reddened. Similarly changed was the large intestine, although to a lesser degree.

"The liver was definitely enlarged, the center of the ascini was straw yellow; the consistency of the liver appeared to be lower than normally.

"The gallbladder, bile ducts and pancreas were negative.

"The spleen was somewhat enlarged, rich in blood, softer than normal.

"The adrenals were swollen, the cortex being edematous and less rich in lipid than usual.

"The kidneys were swollen, softer than normal in consistency, the cortex appeared pale greyish pink and the pyramids were slightly darker being greyish red in color. The pelvis, ureter, and bladder were negative. The retroperitoneal tissue as well as the mesentery at its root was infiltrated by edema.

"*Histological Pathology.* (1) *Brain:* Sections taken from the left frontal lobe did not show particular lesions in hemotoxylin eosin stained paraffine sections. (2) *Left Lung:* Sections showed complete atelectasis and the atelectatic lungs covered by an old inflammatory pseudomembrane in advanced organization. (3) *Heart Muscle:* No fatty degeneration. Perpendicular striation mostly preserved. No essential changes morphologically demonstrable. (4) *Liver:* Marked diffuse fatty degeneration. Moderate round cell infiltration of the interlobular connective tissue. (5) *Kidneys:* Slight irregular fatty degeneration of the tubular epithelium; hyperemia of the pyramids. (6) The skin showed exfoliation of the epidermis which, in many places, appeared reduced to one-third of its normal thickness. The desquamated layers of

the epidermis particularly where the separation had taken place showed the prickle cells swollen and light stained and frequently dissociated from one another. The corium and subcutis were not essentially altered.

"*Chemical Analysis.* Boric acid found in 100 Gm. brain tissue amounted to 112 mg. Supposing a weight of 1,000 Gm. for the markedly swollen brain, its total amount of boric acid was 1.12 Gm.

"The liver showed a lesser amount of boric acid, namely 20.6 mg. in 150 Gm. of tissue. This means, suppose the liver weight was 500 Gm.—a total content of 0.068 Gm. boric acid. (Examined by the chemist, Mr. M. DeCarlo and his assistant.)

"*Pathological Conclusions.* The question as to whether the death of the child has occurred due to the boric acid lavage of the empyema cavity must be answered as follows:

"The presence of 1.188 Gm. of boric acid in the brain and liver allows one to draw the conclusion that the amount of boric acid in the whole body certainly was greater than the amount found in these two organs. Since boric acid is eliminated through the saliva, gastrointestinal tract and urine, we have to assume a greater amount of boric acid having acted on the child during the treatment of three days than the chemical examination performed sometime after the administration of boracic acid has been stopped, could reveal.

"The fact that 3 Gm. of boric acid can prove fatal to an infant illustrates the significance of the 1.12 Gm. boric acid being present in the brain alone, which means in other words, that more than a third of a possibly fatal dose was contained only in the brain.

"As to the empyema being a possible cause of the fatal outcome, it must be admitted that the debilitated state of the child due to the severe infection has furthered the deleterious action of the boric acid on the child's organism.

"The conclusions drawn from the chemical examination have been confirmed by the clinical symptoms offered by the child."

COMMENT

A consideration of this case leaves no doubt that boric acid can be absorbed from the surface of an empyema cavity covered with a pseudomembrane. Until the patient received the boric acid irrigations his clinical condition was favorable and the picture

of increasing intoxication started only after they were started. It continued after the boric acid had been discontinued.

It has been suggested¹² that in such cases an idiosyncrasy to borates may exist. A review of the literature and our experience in this case furnishes no evidence that such is the situation. It seems more logical to assume that borates absorbed into the tissues (particularly the liver and brain) of any individual or experimental animal up to a toxic level have the power to produce fatal depression and shock.

The concomitant appearance of a toxic, erythematous skin rash occurs so frequently in all instances that this must be regarded as a part of the syndrome in borate intoxication.

Conclusive evidence exists that borates clinically and experimentally have been absorbed through living human skin (even when ulcerated or burned), wound surfaces, mucous membranes of the gastrointestinal tract and mouth, subcutaneous tissues, the venous system, and the pleura in amounts sufficient to produce intoxication. It should be noted that such intoxication often has occurred in situations in which there were large absorptive areas exposed to continuous borate administration. It does not seem that the relative absorptive power of such surfaces has been an important factor.

Interesting indeed are the evidences of local irritation, amounting in some cases to gangrene, produced by the application of borates. The experiments of Hoffman and of Puppe mentioned earlier seem to link up with the similar clinical experiences of Chauvin¹⁰ and of Michon.²² The former reports a case of gangrenous cystitis in which glycerin was used for postoperative retention. In the discussion of his paper it is mentioned that Carbineau, in 1909, first used boric glycerin 10 to 100 parts for postoperative retention with violent reaction when used in an empty bladder. The latter tabulates twenty-two instances in which boric glycerin instillations successfully re-established bladder function after periods

of postoperative retention. He also warns that boroglycerin in an empty bladder produces hemorrhagic cystitis. One of us (J. F. C.), without definite proof, believes that he has experienced less postoperative hemorrhage after transurethral resection of the prostate when normal saline was substituted for saturated boric acid solution as a bladder irrigant.

In consideration of the predominate opinion that boric acid is an inefficient antiseptic and cannot be shown to have any wound healing properties, there are many substances less dangerous and in all respects more effective. For the irrigation of eyes, ulcers, and infected or necrotic wounds, normal saline is physiologic to the tissues and accomplishes mechanical irrigation equally well. In necrotic, infected wounds or cavities, potassium permanganate in weak solutions (1:10,000) and hydrogen peroxide are safer and better antiseptics because of their oxidizing qualities. With the advent of the local application of the sulfa drugs still more effective bacteriostatic measures are at hand as substitutes for the borates.

CONCLUSIONS

1. A case of fatal borate poisoning resulting from the continuous irrigation of an empyema cavity with saturated boric acid solution is presented.
2. A review of the clinical and experimental literature on borate poisoning given here seems to indicate that boric acid and its related compounds are more dangerous as irrigants and local medicaments than is commonly assumed.

REFERENCES

1. AIKMAN, JOHN. Strychnine poisoning in children. *J. A. M. A.*, 95: 1661-1665, 1930.
2. BASTEDO, W. A. *Materia Medica, Pharmacology, and Therapeutics*. 2nd ed., pp. 500-501. Philadelphia, 1913. W. B. Saunders Co.
3. BAZIN, A. T. Acute boracic acid poisoning. *Canad. M. A. J.*, 14: 419-420, 1924.
4. BELLIS, CARROLL J. An improved apparatus for tidal drainage of the urinary bladder and empyema cavities. *Surgery*, 8: 791-797, 1940.

5. BEST, C. H. Report of a case of boric acid poisoning. *Tr. Chicago Path. Soc.*, 6: 161-168, 1903.
6. BIRCH, JOHN. Fatal poisoning by borax. *Brit. M. J.*, 1: 177, 1928.
7. BROSE, L. D. Death following the external use of powdered boracic acid. *Med. News*, 43: 100-200, 1883.
8. BROWN, W. L., BROWN, C. P. and MURPHY, J. L. Note to the Editor. *J. A. M. A.*, 106: 1221, 1936.
9. BUZZA, A. and CERRATOLA, R. E. Toxic action of boric acid and borate which are employed as conserving and antiseptic substances. *Rev. Assoc. méd. argent.*, 46: 1493, 1932.
10. CHAUVIN, E. Resection of the pre-sacral nerve for obstinate cystalgic phenomena following an intravesicular injection of glycerine. *J. d'urol.*, 30: 201-205, 1930.
11. CUSHNY, ARTHUR R. Pharmacology and Therapeutics. 12th ed., pp. 793-794. Philadelphia, 1940. Lea and Febiger.
12. DOPFER. Ueber einen Todesfall nach Anwendung de Offizinellen Borsalbe einen Brandwunde. *München. med. Wchnschr.*, 52: 763, 1905.
13. Editorial. Boric acid and a hospital accident. *J. A. M. A.*, 88: 841-842, 1927.
14. FORSYTH, DAVID. Coeliac disease or boric acid poisoning. *Lancet*, 11: 728-730, 1919.
15. GISSEL, HEINRICH. A contribution to the toxicity of boric acid. *Zentralbl. f. Chir.*, 60: 1635-1638, 1933.
16. GRAFENBERG, ERNST. Personal communication to the authors.
17. KAHLENBERG, LOUIS. Passage of boric acid through the skin by osmosis. *J. Biol. Chem.*, 62: 149-156, 1924.
18. MAGUIRE, G. D. Boric acid poisoning. *Practitioner*, 97: 508-581, 1916.
19. MCINTYRE, A. R. and BURKE, C. J. Boric acid poisoning—intravenous in man. *J. Pharmacol.*, 60: 113, 1937.
20. McNALLY, W. C. and RUST, C. A. The distribution of boric acid in human organs in six deaths due to boric acid poisoning. *J. A. M. A.*, 90: 382-383, 1928.
21. McWALTERS, J. C. Note on the effects of borax in infants. *Lancet*, 2: 369, 1907.
22. MICHON, LOUIS and BOUVIER. Treatment of post-operative retention of urine. *Presse méd.*, 33: 1556-1558, 1925.
23. MOLODENKOW. Quoted by Tillman. Textbook of Surgery. 2nd. Am. Ed., 1: 160, 1899.
24. NEGRI, GIOVANNI. On the distant toxicity of boric acid. *Rassegna di terap. e pat. clin.*, 1: 472-476, 1929.
25. NEUENSCHWARDER, W. Hematuria after instillation of borated glycerin into the bladder. *Schweiz. med. Wchnschr.*, 61: 209, 1931.
26. PEYTON, HARRY A. and GREEN, DANIEL. Boric acid poisoning. *South. M. J.*, 35: 1286-1288, 1941.
27. POTTER, CARYL. A Case of borax poisoning. *J. A. M. A.*, 76: 378, 1921.
28. SANDERS, J. H. Boracic acid poisoning. *Brit. M. J.*, 1: 605-606, 1912.
29. SAJONS, L. T. DE M. and HUNDLEY, J. WARREN. Boric Acid, the Cyclopedia of Medicine II: 733-741. Philadelphia, 1936. F. A. Davis & Co.
30. TRUMPER, MAX. Some recent advances in toxicology. *Internat. Clin.*, 40: 233-246, 1930.
31. WOOD-LAWALL. Acidieum Boricum, United States Dispensatory. ed. 22, p. 21-24. Philadelphia, 1937. J. B. Lippincott Co.
32. WILSON, P. A case of boric acid poisoning. *J. Med. Soc. District of Columbia*, 14: 329-331, 1915.



CONTINUOUS CAUDAL ANESTHESIA*

PRELIMINARY REPORT OF A NEWLY MODIFIED TECHNIC

A. CHARLES POSNER, M.D.

Visiting Obstetrician, Harlem Hospital

AND

IRWIN M. BUCH, M.D.

Resident Obstetrician, Harlem Hospital

NEW YORK, NEW YORK

THE authors wish to describe a newly modified technic for the administration of continuous caudal anesthesia in obstetrics, as originally reported by Hingson and Edwards.¹

We have observed three marked disadvantages to the original method: The most important objection is that the physician must administer the anesthetic agent (procaine) to the parturient at regular intervals of thirty to forty minutes. For a busy obstetrician, this technic is impractical, as he can thus care for only a single patient in labor at one time. Second, special apparatus would be needed to make painless labor available to a large portion of the public; this is not feasible in these times. Third, the continual handling of the apparatus each time the medication is injected increases the likelihood of contamination.

By a simple modification of technic which ensures continuous rather than repeated fractional dosage, we believe that we have eliminated these three disadvantages and at the same time made the method safer.

TECHNIC

For the original injection, we follow the method and observe the precautions described by Edwards and Hingson.¹ However, we vary the volume of 2 per cent procaine from 30 to 50 cc. In the early first stage, 30 cc. are sufficient, but during the second stage, 50 cc. are required. An initial injection of more than 50 cc. may result in procaine excitement.

We prefer an ordinary large spinal tap needle to the malleable type. As in the

original technic, the skin and subcutaneous tissues are first infiltrated. The skin is pierced about one inch caudad to the sacral hiatus. The spinal needle is allowed to run in the subcutaneous tissue until the point reaches the level of the sacral hiatus. The hillock of the needle is then raised, with resultant lowering of the point. The sacrococcygeal membrane is pierced and the sacral canal entered. The operator next depresses the needle so that it returns to its original direction, almost parallel to the skin, after which he inserts it two inches up the sacral canal. The needle is, therefore, buried up to the hillock, if possible; it is thus anchored and protected.

After insertion, the needle is connected by means of ordinary infusion tubing to a small Kelly flask or similar container. Fifteen minutes after the initial injection, a slow, continuous drip infusion of eight to ten drops (0.5 to 0.6 cc.) of 2 per cent procaine per minute is begun. The patient, therefore, receives the equivalent of "20 cc. every thirty to forty minutes," as recommended by Hingson and Edwards.¹ This dosage may be varied according to the needs of the patient. We have found a dosage of twelve to fourteen drops per minute more satisfactory.

Infusion tubing is readily obtainable in any hospital and the container for the procaine is easily improvised. A small Kelly flask may be employed. For our first case we used the barrel of the syringe employed to fill a Voorhees' bag. We now have an old cylinder, opened at the bottom, originally used thirty years ago, when salvarsan was given by infusion. This cylinder, which is graduated at 10 cc. intervals, allows a

* From the Obstetric Service of Dr. F. A. Kassebohm, Harlem Hospital, New York.

check on the rate of infusion during short intervals of time.

The use of the Lemmon mattress, though not essential, allows the patient greater freedom of motion.

REMARKS

We believe that the modified technic here presented eliminates the three objections to the original method which were stated above. Several patients may now be attended at a single time and watched by any attendant, not necessarily a physician. The apparatus, which is readily improvised, does not necessitate the manufacture of new material. After the apparatus has been set up, it is automatic and does not require frequent handling, with possible contamination.

We also believe this method of administration to be safer than the original. After the initial injection, procaine is slowly replaced at the rate at which it is metabolized. The nerves which are blocked are, therefore, continuously bathed by a constant amount of procaine. Since infusion takes place at such a slow rate, any toxic symptoms will develop so gradually that their development may be checked in the early stages by slowing or stopping the infusion. On the other hand, with the injection of large amounts at intervals and corresponding sharp increases in the rate of absorption, any toxicity occurring after an injection will be sudden and more severe. It is recalled, of course, that the antidotes for procaine are the barbiturates.

At this writing, we have performed during the past four months more than 100 caudal blocks, including single injections and the continuous type. With the technic just described, our type of service at Harlem Hospital should make available about two or three continuous caudal anesthetics a day. We are now preparing a detailed analysis of our results, which we expect to publish in the near future. We are publishing this preliminary report on technic only so that painless labor may be

used sooner by more obstetricians and its advantages thus made available at an earlier date to a greater number of expectant mothers.

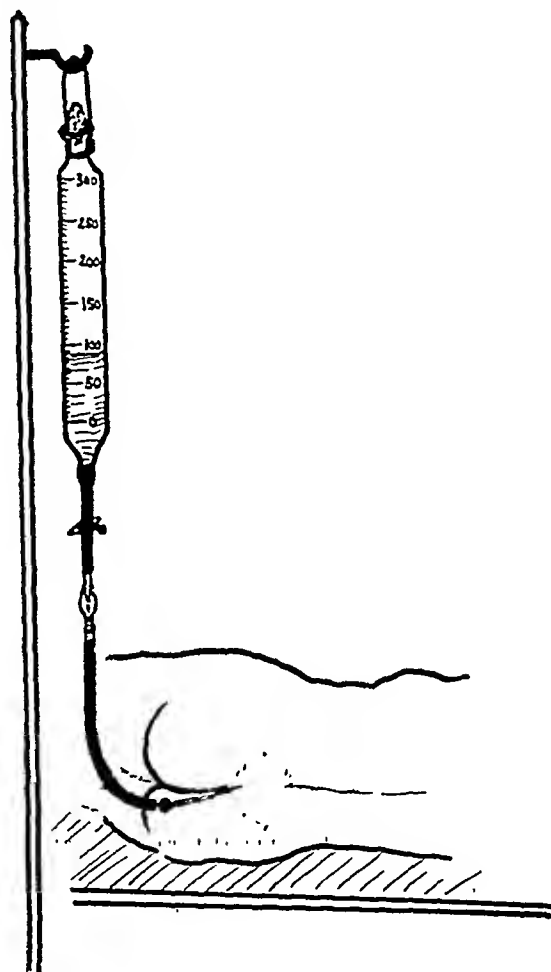


FIG. 1. The graduated container (Salvarsan Tube Vitax No. 4010) hangs from a stand, and is connected by means of ordinary infusion tubing to an ordinary spinal tap needle (B-D Yale-19G-3") placed in the caudal canal. About fifteen minutes after the initial caudal injection has been effective, the infusion is begun at about twelve drops per minute (45 cc. per hour). The rate of flow is regulated by opening or closing the stop cock on the infusion tubing or varying the height of the container of procaine.

SUMMARY

A modification of the original fractional technic of administering caudal anesthesia, first described by Edwards and Hingson,¹ is reported. After the initial injection, a continuous slow drip infusion is established and continued throughout labor.

This method the authors believe to be safer than the original. By eliminating three disadvantages, namely, frequent injections of the anesthetic, the necessity of special apparatus, and repeated handling of the apparatus, the modified technic

becomes more practical and available to a greater portion of the parturient population.

REFERENCE

1. EDWARDS and HINGSON. *Am. J. Surg.*, 37: 459-464, 1942; *J. A. M. A.*, 121: 225-229, 1943.



VERSIONS consist of a turning of the uterus as a whole (flexion being disregarded) about an imaginary axis situated in the upper third of the cervix. Any type of version may be associated with any type of flexion.

CAUDAL ANESTHESIA IN OBSTETRICS

A. C. MIETUS, M.D.

AND

R. M. MITCHELL, M.D.

MILWAUKEE, WIS. AND JAMAICA, N. Y.

MILWAUKEE, WIS. AND BROOKLYN, N. Y.

IN a recent paper,¹ a review of the first 400 caudal anesthetics administered on the obstetrical service of Dr. Albert H. Lahmann at the Milwaukee County Hospital was reported. That series is herein augmented by an additional 400 cases collected from both his service and that of Dr. Thurston S. Welton at Greenpoint Hospital, Brooklyn.

Originally adopted for outlet forceps and episiotomies—of which, incidentally, all our primiparae are given benefit—we have since extended the use of caudal anesthesia to all obstetrical procedures, excepting internal versions, yet including cesarean sections. For the most part the caudal block was administered to the women of this series in the second stage of their labor for the actual delivery of their newborn. Attention is here drawn to the work of Dr. Hingson and Dr. Edwards² who have elaborated further on this type of anesthesia and have introduced a technic for the continuous extradural administration of an anesthetic reagent throughout the first stage of labor as well.

The great number of medications and measures of all sorts which have been suggested in the voluminous literature on the subject attest to the fact that no one single stereotyped analgesic or anesthetic is adaptable to all obstetrical cases. Yet in spite of its certain disadvantages, which will be discussed later, it appears that in this perennial quest caudal block most nearly approaches the answer to the problem of alleviating the sufferings of the woman in labor.

The sacral hiatus, which is produced by the embryological failure of development of the spinous process and the laminae of the fifth sacral vertebra, is found to be inconsistent in both size and shape. Although it usually is triangular, with its

apex being designated by the fourth sacral spinous process and its base bounded laterally by the sacral cornua, not infrequently it assumes a rhomboid rather than a triangular outline. This observation is noted in those instances in which a tubercle, the rudimentary spinous process of the first coccyx, is prominent. Sometimes the sacral hiatus is nothing more than a narrow slit and only rarely is it found clinically to be as large as the usually described adult's thumbnail. Similarly, the sacrococcygeal membrane of Cathelin is of varying consistency, in some patients being thin and readily penetrable and in others thick and densely fibrous.

Experience has shown that either the lateral decubitus or the knee-elbow position of the patient at the time of injection may be used. The latter is given preference since, although admittedly awkward to the pregnant woman, it retains the symmetry of the arched back; it enlarges the diameters of the sacral hiatus; and, by drawing the overlying integument taut, it exaggerates the anatomical prominences.

The anesthetic used in our clinics is a 2 per cent aqueous solution of metycaine (gamma/2methyl-piperidino/-propyl benzoate hydrochloride). It is a rather stable solution which tolerates sterilization by heat and does not deteriorate on standing. The latent period before the onset of its action is not unduly long and its effect is more enduring than that produced by procaine. No adrenalin is added and it is to this factor that we attribute the scarcity of untoward reactions since none of the vasomotor, respiratory, gastrointestinal or other effects of adrenalin on the autonomic nervous system are produced.

The instrumentarium required consists merely of a 25 cc. syringe and an eighteen gauge spinal puncture needle with its

stylet. With the patient in the knee-elbow position, the operative field is prepared with a reliable skin antiseptic, the sacral hiatus is identified, and the needle is introduced almost perpendicularly to the skin surface. Penetration of the fibrous sacrococcygeal membrane having been effected, as evidenced by the sudden release in the resistance offered, the hub of the needle is depressed so that its long axis lies practically parallel to the long axis of the sacrum, and then advanced a few centimeters to guarantee its presence well in the sacral canal. With an empty syringe, aspiration is attempted. If blood is obtained, the needle must be removed and reinserted lest the solution be introduced directly into the blood stream. On the other hand, if the dural sac has been penetrated, as evidenced by the aspiration of cerebrospinal fluid, the entire process ought be discontinued. The anesthetic is injected slowly. If questioned, the patient will usually admit a "crampy" sensation in one or both legs during the injection. This reaction practically insures the successful infiltration of the sacral canal.

Shortly after the anesthetic is given a dramatic change occurs in the patient. The outcries that accompany each pain are stilled, the exhausting effort to bear down disappears, and the parturient becomes comfortable and co-operative. However, the rhythmic uterine contractions continue painlessly. Anesthesia of the perineum becomes evident several minutes after analgesia is obtained. Beginning in the region of the anus, it extends fanwise: upward over the symphysis pubis, laterally over the inner aspects of the thighs, and backward over the sacral and gluteal regions, the sum effect resulting in a typical "saddle" anesthesia. The height to which anesthesia ascends is almost directly proportional to the volume of anesthetic solution injected. It appears that when larger quantities are used the anesthetic agent dissects its way upward under pressure in the extradural space to bathe the nerves at higher levels in the spinal col-

umn. It has been noted, for instance, that although 25 cc. of the solution will ordinarily give saddle anesthesia only, 40 cc. or more will almost invariably give anesthesia to the level of the umbilicus. It is this phenomenon which permits the performance of cesarean sections under caudal block. Simultaneously, the musculature of the pelvic and perineal floors becomes paralyzed. This complete relaxation is a welcome development since it minimizes the incidence of vault tears and facilitates such obstetrical manipulations as the application of forceps, the decomposition of breeches, and manual or instrumental rotations. When small doses of solution are injected, sensory and motor function of the lower limbs are retained. No influence whatsoever on the fetus has been noticed. Furthermore, the third stage of labor is unimpaired. The incidence of retained placenta is not increased. Inasmuch as the myometrium does not lose its tonicity, blood loss is minimal. Sensation recurs inversely to the direction in which it extended. The puerperium is unaffected.

The procedure is not without untoward effects. A sudden transitory drop in blood pressure was noted not infrequently in those patients in whom large single injections, e.g., 60 to 70 cc. were given *en masse*. It was observed also that this fall could be prevented by the preoperative administration of a small dose of ephedrine sulfate intramuscularly. Such transitory episodes as vertigo, jactitation, disorientation, auditory and visual hallucinations, apprehension, or actual generalized clonic convulsions—of too short duration to permit active countermeasures being instituted (the longest lasted two minutes)—occurred in approximately 3 per cent of the series. It should be mentioned here that the incidence of those untoward reactions in patients adequately sedated with barbiturates was nil. Whether this is purely coincidental or whether the barbiturates here counteract toxic effects of metycaine remains to be determined.

There was no instance of morbidity or mortality which could be attributed to the anesthetic procedure. It is not beyond imagination, however, to visualize how an inadvertant massive intrathecal or intravenous injection, rather than extradural, could terminate fatally. It is for this reason that the administration of the reagent must be attended to with extreme caution and punctilious regard. Furthermore, even though it was not observed in this series, there is reason to believe that infection might occur at the site of injection here as it might anywhere else when the integrity of the integument is broken unless scrupulous aseptic care be followed. No residual neurotropic effect was noted in any of the cases. Whether or not some long-delayed undesirable aftermath occurs from the introduction particularly of large quantities of a foreign solution into the extradural space remains a point of conjecture.

Comprising this series of 800 cases, 703 were primiparae and ninety-seven were multiparae. By far and large, the greatest number were delivered by low forceps and episiotomies. There were some midforceps and only one high forceps. As an experiment, several were permitted to deliver spontaneously either with or without the benefit of a perineotomy. There were fifty-four breech deliveries, in thirty of which the breech was broken up and extracted. In numerous instances transverse forceps were applied and in several cases it was necessary to rotate occiput posteriors adopting either the Kielland technic or the Scanzoni maneuver. Twelve women were delivered by cesarean section and in one a Porro section was performed, all entirely under caudal anesthesia. In one case internal podalic version and extraction was attempted but the caudal block was found insufficient and was of necessity augmented by ether. It might be mentioned that in this series of 800 cases were nine women afflicted with severe rheumatic heart disease, four with pulmonary tuberculosis, and twenty-two with toxemias of varying degrees, three of whom had

eclampsia. Two of the patients had placenta previa; the first, with a complete type was delivered by cesarean section; the other with a partial previa was delivered by Braxton-Hicks extraction. One abruptio placenta was treated by rupturing the membranes and stimulating uterine contractions with pituitrin. In two instances delivery was facilitated by the use of Duehrssen's incisions.

In 381 of the patients, 25 cc. of 2 per cent metycaine were injected. In 368, 35 to 40 cc. were given and in the remaining fifty-one cases, varying quantities from 10 to 70 cc. were used. It appears that for ordinary obstetrical procedures performed per vaginam under the single dose caudal block, 35 cc. is adequate.

In 554 cases in which this record was kept, the average latent period between the time of administration of the anesthetic and the time anesthesia first became evident about the anal region was 6.9 minutes. The average duration for anesthesia of this series was one hour and twelve minutes.

Ideal results, i.e., anesthesia of the perineum as well as analgesia or the loss of uterine contraction pain, were obtained in 714 cases; in 50 women anesthesia of the perineum developed but the patient either remained aware of contraction pain or complained of pain when traction was applied with the forceps; while in 36 cases the block had failed completely. There is no question but that the failures were, for the most part, due to technical errors on the part of the anesthetist.

CONCLUSIONS

The reintroduction of caudal block into the obstetrical armamentarium presents a method of anesthesia of distinct superiority for operative procedures. Although certainly not a panacea, its objectionable features are outweighed by its advantages. Inasmuch as the technic of administration requires a certain amount of skill, the results obtained are directly proportional to the experience and practice of

the operator. Untoward effects occur but are transient and leave no deleterious sequelae. Caution must be exercised to avoid intrathecal and intravenous instillations of the solution. That infections over the site of injection of the reagent might occur is granted, but none was seen in this series.

In its favor, caudal anesthesia offers relief from pain and relief from the excitability attendant particularly with the excitomotor reflex in the second stage of labor. It permits uterine contractions to continue unaffected. By relaxing the musculature it preserves the perineal and pelvic floors. It does not interfere with the normal mechanisms of labor and is applicable to practically all types. It does not prolong the first stage; it facilitates operative vaginal deliveries in the second stage. It permits complete co-operation of the parturient and it presents no peril to her newborn. The third stage of labor is unaltered

and the incidence of postpartum hemorrhage is decreased. The patient is comfortable on her return to bed and her puerperium is unaffected. There is no influence on the subsequent involution of the pelvic organs. The advantages over inhalation anesthesia are obvious: there is no excitement stage, no nausea or vomiting, no danger of explosion; the disturbed acid-base balance, the shock, the dehydration or the postanesthetic pulmonary complications, which so frequently accompany prolonged inhalation anesthesia, are absent. It can be used with relative impunity in patients with cardiac, renal or pulmonary disease.

REFERENCES

1. LAHMANN, ALBERT H. and MIETUS, A. C. Caudal anesthesia: its use in obstetrics. *Surg., Gynec. & Obst.*, 74: 63-68, 1942.
2. HINGSON, ROBERT A. and EDWARDS, WALDO B. Continuous caudal analgesia in obstetrics. *J. A. M. A.*, 121: 225-229, 1943.



AVERTIN ANESTHESIA IN GYNECOLOGY*

REPORT ON A SERIES OF CASES

LIEUT. DANIEL B. DORMAN, M.C., U.S.N.R.

WASHINGTON, D. C.

EVER since Willstatter and Duisberg¹ first published their paper in Germany, in 1923, describing the synthesis of tribromethyl alcohol, avertin has received wide attention and use. Butzengeiger² and Eichholtz³ were the early supporters of its use as an anesthetic in Germany. Among the early published reports of avertin as used in this country are papers by Guttman,⁴ Sise,⁵ and Nesbit.⁶ At first this new anesthetic was used for complete anesthesia, being employed in large dosages. Because of errors in judgment as to dosage and as to choice of patients, several deaths occurred which were blamed on the new drug. This stigma has never been entirely erased from the minds of the profession. But with a general understanding of the dosage to be used and of the dangers to be avoided, avertin has come to be one of our common and reliable anesthetics.

There have been numerous and sometimes varying reports regarding the effects of avertin on the respiration, pulse, blood pressure, and blood chemical levels. In general it may be said that (1) the respiratory rate may be slightly increased, though the respiratory volume is decreased; (2) the pulse is not much affected, with usually a slight increase in rate; (3) the blood pressure often falls, with at times an alarming drop, though this effect seems to vary with the patient; (4) changes in blood levels of the carbon dioxide combining power, non-protein nitrogen, sugar, etc., are so slight as to be unimportant. Since avertin is detoxified in the liver by combination with glucuronic acid, and is excreted by the kidneys in that form, it is only natural that attention should be focused on these organs

for any possible ill effects from the anesthesia. But it is believed that no permanent damage occurs to the normal liver or kidney from avertin as used in the anesthetic dose. The same cannot be said of diseased organs, however, and evidence of severe liver or kidney damage in a patient for operation precludes the use of avertin.

For use in gynecology avertin has been well reported by Peterson and Pierce,⁷ Bemis,⁸ Reycraft,⁹ and others. At Kensington Hospital for Women during the past nine years avertin has been a favorite anesthesia, being used almost routinely for longer gynecological operations. R. B. Schutz¹⁰ first reported a preliminary series of our patients in 1934, at which time 353 cases were included. He emphasized the benefits of using this anesthetic not merely as a basal anesthetic (57 per cent of plastics and 28 per cent of sections needed no supplementary gas or ether), but also to lessen the amount of required inhalation anesthesia. This advantage was directly responsible for a decrease in postoperative complications. The other great claim for its use was the amnesia experienced by the patient, with consequent lack of apprehension and fear. E. A. Schumann¹¹ made a subsequent report on our series in 1938, when the number of cases had reached 1,100. In a paper discussing various types of anesthesia he described our clinical results with avertin. In addition to confirming the above advantages he emphasized that avertin anesthesia alone, or with a small amount of supplementary nitrous oxide-oxygen mixture, will usually give relaxation that is adequate for gynecological operations. The full surgical anesthesia required for upper abdominal work has no

* From the Kensington Hospital for Women, Philadelphia.

place in gynecology. As Dr. Sehumann explained, we usually use morphine-seopolamine "analgesia" alone for vaginal plastic operations in women over fifty-five years of age.

From what has been said above, and from what follows, it may be seen that we do not agree with the position taken by some: "the use of avertin as an anesthetic has been abandoned,"¹² and that now it should be used only as a basal narcotic; nor that it "is not to be used routinely in hospitals."¹³ Though our percentage of patients requiring no inhalation anesthesia whatsoever is not as high now as originally reported early in the series, we believe that the small amount of nitrous oxide usually used for a few minutes at the start of the operation to supplement the avertin does not constitute a true "anesthesia."

PRESENT STUDY

The present paper is meant as a further report on our series, which has now reached 1,800 cases. Recently a study was made of ninety-eight consecutive avertin anesthetics with particular attention to (1) the results obtained; (2) the effect on the blood pressure; and (3) the effect on the kidneys. The operations included both vaginal plastics and sections, in white women of varying ages. Patients who were considered bad risks for avertin because of shock, renal disease, etc., were anesthetized by other means. As stated above, women over the age of fifty-five scheduled for plastic operations alone were given morphine-seopolamine "anesthesia" according to our custom; but otherwise cases were not selected.

Results. In Tables I to IV the results obtained are listed as "excellent," "good," "fair," and "poor." Naturally, this is an arbitrary classification, based largely on the amount of time that supplementary anesthesia was required in relation to the length of the operation. Thus the results were called "good" if nitrous oxide mixture was used up to one-third of the operating time; "fair" if used up to two-thirds of the

operating time; and "poor" beyond that. But cases classified as "poor" nevertheless received far less inhalation anesthesia than they otherwise would have needed, because of the dilute mixture of nitrous oxide used. Only rarely was ether added.

Our method was as follows: A cleansing soap suds enema was given the night before operation, and repeated in the morning. Three gr. of phenobarbital were administered at bedtime the evening preceding operation. One-quarter gr. of morphine sulphate and $\frac{1}{150}$ gr. of atropine sulphate were the usual preoperative medication, given by hypodermic injection one hour before the scheduled time of operation. We tried to give the avertin twenty to thirty minutes before operation so as to obtain the maximum effect at the time when the incision should be made. This timing of necessity varied considerably in the operations studied, though the time of administration did not seem to have much influence on the result obtained. (Table I.)

TABLE I

Time of Administration Before Operation	Excellent	Good	Fair	Poor	Totals
0-10 min.....	2	0	1	1	4
10-20 min.....	10	12	11	5	38
20-30 min.....	11	8	10	6	35
30-40 min.....	4	2	0	4	10
40-60 min.....	3	0	1	3	7
61 min.+....	0	0	3	1	4
	30	22	26	20	98

The usual dose of avertin used by us (in seventy-seven of the ninety-eight cases studied) is 100 mg. per kilogram of body weight. We do not administer more than 7 cc. of avertin at a time, so patients weighing 155 pounds or more received less than 100 mg. per kilogram, as did a few other patients at the request of certain surgeons on our staff.

However, we had considerably better results in those who received the full dose

of 100 mg. per kilogram than in those with the smaller dosages. (Table II.)

TABLE II

Dosage of Avertin Used	Excellent	Good	Fair	Poor	Totals
100 mg. per kilo	26 (34 %)	17 (22 %)	18 (23 %)	16 (21 %)	77
Less than 100 mg. per kilo	4 (19 %)	5 (24 %)	8 (38 %)	4 (19 %)	21
	30	22	26	20	98

The avertin has been given for years by the surgical supervisor, who administers it slowly by rectum after careful preparation and testing, according to the instructions coming with the fluid. When amnesia has developed, the patient is placed on the stretcher and moved to the anesthesia room, where she is watched closely by a nurse until the anesthetist takes over. This period of observation is important, to prevent the "tongue swallowing" which is so apt to follow relaxation of the jaw muscles and abolition of the gag reflex. It is just at the start of the operation, in the case of abdominal sections, that we often administer a dilute mixture of nitrous oxide for a few minutes, while the incision is made and the packing placed in position. In vaginal plastic operations supplementary anesthesia is less often required, as seen in Table III. If it is needed at all, it is usually when perineal repair is begun.

TABLE III

Type of Operation	Excellent	Good	Fair	Poor	Totals
Vaginal operation	11	2	1	1	15
Abdominal section.....	9	15	18	13	55
Vaginal operation plus abdominal section.....	6	4	6	5	21
Other operations for hernia, breast tumor, etc.....	4	1	1	1	7
	30	22	26	20	98

Postoperatively, the patients are closely observed until the gag reflex returns, though amnesia and sleep usually continue for a number of hours after the return to the ward. Sometimes it is necessary to give a hypodermic of morphia for restlessness, and occasionally respiratory depression or a marked fall in blood pressure are noted at this time. If this becomes alarming, coramine or caffeine may be used for stimulation. The postoperative vomiting and gagging, so common with inhalation anesthesia, are almost completely eliminated; if present at all, they are represented only by a transitory discomfort. Amnesia, for which the women are so thankful, is marked by the question so often asked by the reacting patient, "Is it all over?"

Table IV gives the results obtained as classified by the ages of the patients, which range from thirteen to sixty-two years. From these figures one might argue that avertin is more effective in the older group of patients. But we believe that this is partially explained by the larger percentage of vaginal plastic operations in the older patients; and aside from the personal factor, which cannot be disregarded, results depend largely on (1) the dosage used, and (2) the type of operation.

TABLE IV

Age of Patient (in Years)	Excellent	Good	Fair	Poor	Totals
10-19	0	1	3	1	5
20-29	5	3	9	5	22
30-39	7	9	8	5	29
40-49	13	7	5	7	32
50+	5	2	1	2	10
	30	22	26	20	98

Blood Pressure. We have noted for some time that there is often a marked fall in blood pressure following avertin anesthesia. Similar falls have not been found following other forms of anesthesia with the same preoperative medication. For this reason the blood pressure was taken postoperatively in this series to determine how

long the pressure remained depressed. In thirty-four of the ninety-eight cases no fall whatever was noted. (Table v.)

TABLE V

Postoperative Blood Pressure	Total Series	Stimulants Used	Pre-operative Blood Pressure 150 or Over
No fall (or slight rise).....	34	0	0
Fall occurred.....	64	2	7
Normal postoperatively.....	14	0	0
Normal after 3 hours } Within 10 mm.	9	0	1
Normal after 8 hours } 14	0	0	
Slightly low at 8 hrs. (10-40 mm. low).....	21	1	5
Very low at 8 hrs. (over 25 mm. low and below 100 mm.)	2	1	1
Not recorded at 8 hrs.; low at 3 hrs.....	4	0	0
Totals.....	98	2	7

In the remaining sixty-four cases, other factors such as surgical shock may have played a part. But resuscitation (coramine or intravenous therapy) was used only twice in the series; and in only two cases in which the blood pressure was recorded eight hours after operation, was the pressure found to be very low. Seven hypertensive patients (with a preoperative systolic blood pressure of 150 mm. of mercury or

more) were included in our series, as no casts were present in their preoperative urines, which showed either no albumin or a faint trace. It is noted in Table v that all of these patients had a fall in blood pressure, the majority of them for a considerable length of time. This has been our experience previously, and though we believe that avertin may be given safely in such patients, a marked fall in blood pressure is to be expected.

Listed below are the blood pressure readings of the five patients in the series who showed the greatest fall. (Table vi.) As noted above, this is far from the usual experience.

Urinary Findings. We refrained from giving avertin to patients who showed microscopic evidence of renal disease or much albumin in the preoperative urine specimen. Though both albumin and casts were often present in postoperative urine samples, we have found them also when other anesthetics have been used, such as ether or even morphine-scopolamine "anesthesia" alone. These pathological danger signs seem to be caused merely by a temporary condition, to which probably the shock of operation also contributes. The commonest urinary finding of note following operations under avertin was casts, either with less than a faint trace, or 2+, of albumin (forty-three cases) or with considerable albumin (ten cases). These findings, however, did not persist usually

TABLE VI

Age of Patient	Type of Operation	Duration of Operation	Blood Pressures						Comments
			On Adm.	A.M.	Pre-op.	Post-op.	3 Hrs.	8 Hrs.	
41	Appendectomy.....	25 min.	110/70	122/80	58/40	70/48	76/42	84/54	Apprehensive Coramine given postoperatively
52	Simple mastectomy.....	48 min.	170/90	126/72	.....	54/38	84/52	105/70
45	D. & c., cervical amputation, perin'r'haphy.....	36 min.	159/84	176/78	65/40	92/60	98/66	P.I.D.; surg. shock, i.v. fluids, Coramine Retrocecal appendix
44	Supravag. hysterectomy, bilat. salp.-oophorectomy.	100 min.	.....	106/58	.....	55/45?	55/45	80/54
50	Appendectomy.....	61 min.	130/80	134/86	66/52	76/52	84/62	114/72	

even to the third day; and by the tenth postoperative day the kidneys were apparently again functioning normally. Others, such as Pangman,¹⁴ have also compared postoperative urine studies in avertin with controls. Our findings here support the general belief that avertin causes no permanent damage to the normal kidney. Moreover, from time to time a patient has required a second operation, with avertin repeated, and no ill effects were observed.

DEATHS

There was only one death among the ninety-eight cases studied above. This was caused by pulmonary embolus on the tenth postoperative day. But in our total series of 1,800 cases, we have had twenty-one deaths. The primary causes of death have been listed in Table VII. The first three causes of death listed—peritonitis, postoperative intestinal obstruction and embolus—include thirteen cases. Avertin could not possibly have been blamed for these casualties. A brief review of the other eight deaths follows:

TABLE VII

Cause of Death	No. of Deaths
Peritonitis.....	8
Postoperative intestinal obstruction.....	2
Pulmonary or cardiac embolus.....	3
Uremia.....	4
Diabetes with coma; postoperative nephritis.....	1
Anuria (both ureters ligated).....	1
Rheumatic heart disease; shock.....	1
Postoperative thyroid storm; cardiac failure.....	1
Total.....	21

CASE I. Mrs. C. F., age forty-one, was admitted with a third degree prolapse of the uterus and marked hypertrophy of the cervix. The patient was obese and weighed 246 pounds. Her blood pressure was 154/70; preoperative urine showed 2+ albumin with occasional casts. Vaginal hysterectomy was performed under avertin two days after admission. Because of oliguria, blood urea and urea nitrogen were taken on her first postoperative day, but these were normal. Urinary excretion returned, but with persistent casts. The course was satisfactory until her twelfth postoperative day, when vaginal bleeding followed an enema. Two days later secondary suture of the anterior

suture line was done under nitrous oxide anesthesia. Following the bleeding, hemoglobin had fallen to 50 per cent and red blood cells to 3,170,000. Oliguria again resulted, with passage of only 14 ounces of urine in forty-eight hours, despite hypertonic glucose by vein. The patient expired on her sixteenth (and second) postoperative day. No autopsy was obtained. Though she was signed out as uremia and terminal cardiac failure, blood urea on the day of death was 17.8 mg. per cent and urea nitrogen 8.3 mg. per cent. Avertin blame was doubtful.

CASE II. Mrs. E. M., age fifty-five, was admitted for supravaginal hysterectomy and bilateral salpingo-oophorectomy. She weighed 152 pounds. Blood pressure was 148/90; preoperative urine was normal. Following operation oliguria occurred (13 to 20 ounces daily) despite parenteral fluids. Urine showed persistent casts and 2+ albumin. On her second day she complained of abdominal pain; considerable distention developed and grew worse. On her fourth postoperative day blood urea was 112 mg. per cent and urea nitrogen 52 mg. per cent. Râles were heard at her lung bases, without consolidation. Death occurred on the following day, after respirations became rapid and labored. Cause of death was uremia. No autopsy was obtained. Avertin probably was contributory to death.

CASE III. Mrs. M. J., age sixty, was admitted for repair of incisional hernia. She weighed 148 pounds. Blood pressure was 146/92; preoperative urine was normal; blood urea 42, urea nitrogen 20 mg. per cent. Seven cc. of avertin were given (104 mg. per kilo.). Postoperatively dyspnea resulted, apparently from hypostatic congestion. The amount of urine excreted seemed adequate, though there were casts persisting up to the time of her death, with only 1+ albumin. Dyspnea increased without adequate signs of pneumonia to explain her condition. She lapsed into deepening unconsciousness and died on her tenth postoperative day. Autopsy was limited to the abdomen, but showed nephrosclerosis. Cause of death was uremia and hypostatic pneumonia. Avertin probably was contributory to death.

CASE IV. Mrs. A. P., age fifty-nine, was admitted for radical mastectomy because of carcinoma present for two years previously; the lymph nodes were involved. She weighed 182 pounds. Blood pressure was 152/92; urine showed many casts, with 1+ albumin. Seven cc.

of avertin were given (84 mg. per kilo.). Following the operation, which took forty-five minutes, the patient never fully regained consciousness. Her blood pressure remained low, 65/40 and 74/52, and she excreted very small amounts of urine, despite parenteral fluids—3½ and 5 ounces in twenty-four hours respectively. The urine showed many casts, with considerable albumin (2+ and 3+). The patient died on her second postoperative day. The cause of death was nephritis and uremia. Autopsy was not obtained. Avertin probably was contributory to death.

CASE V. Miss R. E., age sixty-seven, was admitted with carcinoma of the transverse colon. She weighed 134 pounds. Blood pressure was 155/90; preoperative urine was normal. blood sugar 165, urea nitrogen 15, mg. per cent; urea clearance 91 per cent. She was given 6 cc. of avertin (100 mg. per kilo.). The carcinoma was resected with the terminal ileum, ascending colon, and hepatic flexure; a side-to-side ileocolostomy was performed; operating time was two hours and twenty-five minutes. Postoperatively the respiratory rate was depressed; blood pressure was 110/90. Diabetic coma was suspected, with blood sugar 400, urea 111, and urea nitrogen 52 mg. per cent. Intravenous glucose and insulin were given, with improvement (sugar 210, urea 90, urea nitrogen 42 mg. per cent). Urine showed less than 1 per cent sugar and no acetone, but persistent casts and 2+ albumin were present. Urinary output was fair. Her fever rose to 106.5°F. terminally on her third postoperative day, and her pulse rate to 160; blood sugar was 325 mg. per cent. A complete autopsy was not obtained, but examination of abdomen showed no peritonitis or leakage from the bowel. Cause of death was listed as *diabetes with coma and postoperative nephritis*. Avertin probably was contributory to death.

CASE VI. Mrs. E. S., age forty-six, was admitted with a large fibroid uterus. The patient was obese. Because of 30 per cent hemoglobin and 1,850,000 red blood cells three transfusions were given before operation. Her heart was enlarged with a loud systolic murmur; blood pressure was 126/60; urine showed 2+ albumin, but was contaminated with blood. Despite three transfusions, vaginal bleeding continued and panhysterectomy was done six days after admission; hemoglobin at that time was 42 per cent and red blood cells 2,420,000. Seven cc. of avertin were used. Following

operation the patient remained semiconscious and moaned with back pain. Only 1½ ounces of urine were obtained by catheterization, showing many casts and 3+ and 2+ albumin. Blood urea was 96, urea nitrogen 45 mg. per cent. On the day following operation, she was returned to the operating room, where she died on the table under ether anesthesia. The right ureter had been divided and the left ureter was ligated in a mass of tissue at the operative site. Cause of death *anuria* from division and ligation of ureters, myocardial degeneration and anemia. No autopsy was obtained. Avertin blame was doubtful.

CASE VII. Mrs. A. T., age sixty, was admitted with a gastric ulcer and stomach retention. She weighed 157 pounds. Blood pressure was 120/90, hemoglobin 50 per cent and there were 2,750,000 red blood cells; rheumatic mitral disease, compensated. Preoperative urine was normal; blood urea was 37, urea nitrogen 17, mg. per cent. Four days after admission, posterior gastrojejunostomy was done under avertin-nitrous oxide anesthesia. Six and eight-tenths cc. of avertin were used (96 mg. per kilo.). Pulmonary edema followed postoperative intravenous injection of 10 per cent glucose; pulse was 144 and thready; blood pressure was 70/40. Respirations remained rapid, and the patient died twelve hours postoperatively. No autopsy was obtained. Cause of death was *rheumatic heart disease* and shock. Avertin blame was doubtful.

CASE VIII. Mrs. E. S., age fifty-three, was admitted for hysterectomy because of fibroids. She weighed 115 pounds. Blood pressure was 180/90; pulse 92 to 100 preoperatively; there was no palpable thyroid enlargement; the heart was normal. Preoperative urine showed 2+ albumin and many white blood cells (voided specimen). Blood urea was 24, urea nitrogen 11, sugar 105 mg. per cent. Five and two-tenths cc. of avertin (100 mg. per kilo.) were given for operation on day after admission. Chronic salpingitis and pyohydrosalpinx complicated the procedure. Her pulse reached 160, and respirations 28, at the end of the operation. The pulse remained rapid, despite therapy, and fever reached 103°F. the first night and 106°F. the second night. The patient was restless and her extremities were clammy. Urine showed many casts and 2+ albumin; the output was adequate. Transfusions and iodine therapy supplemented intravenous fluids and digalen. On the third postoperative day, as fever

reached 106°F. again (by axilla), signs of cardiac failure appeared. The pulse, which had never fallen below 124 since operation, again rose to 160. Blood pressure was 170/90. There was no pain and only slight distention. No apparent pelvic abscess was present, and only serosanguineous drainage from wound drain occurred. Fever reached 109°F. terminally, as the patient died on her fourth postoperative day. Autopsy was not obtained. Cause of death was *thyroid storm*. Avertin blame was doubtful.

Of the eight deaths described above, there were only four cases in which avertin anesthesia probably contributed to the death; and in none of these cases was a complete autopsy granted to confirm the clinical opinion of the cause of death. Before avertin is blamed too harshly, it must be remembered that any other general anesthesia might have produced the same results. All four of our patients died with renal complications between the second and the tenth days postoperatively; but we have had no deaths from respiratory failure or shock alone, caused by avertin.

COMMENTS

Contraindications. Considerable renal damage is our commonest contraindication to the use of avertin. We believe that this decision is wise in view of the renal method of excretion of avertin. We also dislike the use of avertin in the presence of shock with anemia (as in ruptured tubal pregnancy), because of the danger in decreased oxygen-carrying capacity with possible respiratory or circulatory depression. As previously stated, we prefer morphine-scopolamine anesthesia alone for vaginal plastic work in older patients; but we do not hesitate to use avertin for sections in older women if the kidneys are in good condition. Liver disease, colitis, and advanced pulmonary disease are uncommon among our patients, but they have been described also as contraindications. However, we have often performed a hemorrhoidectomy at the end of a plastic operation under avertin, after dilatation of the rectal sphincter and

evacuation of the rectum. Our experience with avertin in obstetrics has been disappointing, with a delay in labor resulting from a period when pains practically cease and the patient becomes unmanageable.

Complications. Respiratory depression and "shock" are the two commonest complications. But we have found serious respiratory depression only occasionally; and a drop in blood pressure is not often accompanied by rapid pulse and other signs of true surgical shock. Such instances invariably respond to prompt therapy. Swallowing of the tongue, accompanied by loss of the gag reflex, and subsequent obstruction to respiration, must be avoided.

Advantages. The advantages of this type of anesthesia fall into three periods. Preoperatively, the patient is spared the consciousness of being brought to the operating room. This mental shock, so dreaded by the apprehensive patient, is entirely eliminated, as the fluid is given in bed by a method made familiar by the previous administration of enemas. During the operation, if supplementary anesthesia is necessary, the stormy second stage is avoided; and only a fraction of the usual inhalation anesthesia is used. Because of this fact, avertin is practicable in mild cardiac and pulmonary complications, with caution observed concerning the loss of the cough reflex. This advantage is also directly responsible for the postoperative advantages of avertin: less perspiration and, therefore, less thirst; less vomiting, and quicker oral intake of fluids; and less atelectasis and pneumonia. The whole postoperative course is apt to be smoother and more uneventful.

Disadvantages. Though we believe that all objections are overbalanced by its advantages, avertin does have some disadvantages. The length of the induction period has been circumvented by our arrangements for administration already described. Likewise we are not disturbed by the slow excretion of the anesthetic; we rather appreciate the postoperative rest and amnesia afforded the woman. The lack

of control of the drug following administration, and the "narrow margin of safety" cannot be disregarded; but consideration of the recognized dosage and of the physical condition of the patient will safeguard against errors. As to individual variations in susceptibility to avertin, more inhalation anesthesia can always be given if the desired relaxation is not obtained; but complete surgical anesthesia is rarely necessary in gynecological operations.

SUMMARY

A series of 1,800 cases of avertin anesthesia is reported, the large majority of operations being gynecological.

Ninety-eight consecutive cases are studied in detail, with particular attention to results obtained, effect on the blood pressure and urinary findings.

Twenty-one deaths in the total series of cases are reviewed.

As a result of our experience, we believe that the advantages of avertin far outweigh its disadvantages; and we agree with Peterson and Pierce⁷ in their conclusion

that "avertin more nearly approaches the ideal anesthetic than any other drug which has been employed in the clinic."

The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval service at large.

REFERENCES

1. WILLSTATTER, R. and DUISBERG, W. *Beitr. d. deutsch chem. Gesellsch.*, 54: 2283, 1923.
2. BUTZENGEIGER, O. *Deutsche med. Wchnschr.*, 53: 712, 1927.
3. EICHMOLTZ, F. *Deutsche med. Wchnschr.*, 53: 710, 1927.
4. GUTTMAN, J. R. *Ann. Surg.*, 90: 407, 1929.
5. SISE, L. F. *Surg. Clin. North America*, 9: 1381, 1929.
6. NESBIT, W. M. *Wisconsin M. J.*, 28: 589, 1929.
7. PETERSON, R. and PIERCE, J. M. *Surg., Gynec. & Obst.*, 55: 191, 1932.
8. BENIS, G. G. *Am. J. Obst. & Gynec.*, 25: 677, 1933.
9. REYCRAFT, J. L. *Am. J. Obst. & Gynec.*, 30: 332, 1935.
10. SCHUTZ, R. B. *Am. J. Obst. & Gynec.*, 28: 439, 1934.
11. SCHUMANN, E. A. *Med. Rec.*, 147: 26, 1938.
12. KAYE, G. *Australian & New Zealand J. Surg.*, 3: 235, 1934.
13. BLOMFIELD, J. *Proc. Roy. Soc. Med., London*, 23: 99, 1929.
14. PANGMAN, W. J. *Southwest. Med.*, 22: 6, 1938.



BACILLUS PROTEUS OX19 AGGLUTINATED BY THE SERUM OF PREGNANT WOMEN*

PRELIMINARY REPORT

I. GRATCH, M.D.

Hahnemann Medical College and Hospital
PHILADELPHIA, PENNSYLVANIA

DURING a series of researches that were conducted at the suggestion of a distinguished colleague for the purpose of making an epidemiological survey to detect, if possible, the incidence of rickettsia diseases (typhus, Rocky Mountain Spotted Fever, etc.) in the Philadelphia area, by means of an agglutination test, using as antigen the different strains of *Bacillus proteus* OX, an interesting fact appeared. The author noticed the exceptional frequency of a positive agglutination test, particularly with the strain *Proteus* OX19, in cases of sera from pregnant women, who had absolutely negative histories, so far as previous typhus or other rickettsial diseases were concerned.

This striking fact led the writer to abandon, temporarily at least, his epidemiological investigation, in order to consider the usefulness of a separate study capable of demonstrating whether the sera of pregnant women do or do not consistently agglutinate the different strains of *Proteus* OX.

After having tried in a few preliminary experiments the strains OX₂ and OXK, attention was concentrated on the strain OX19, because this one seemed to give the most reliable results.

For preliminary researches, the suspension of *Proteus* OX19 was used as antigen. The technic adopted in performing this test is very simple. A drop of the serum to be tested is pipetted with a small pipette (for example, 1 cc. pipette or the ordinary capillary-pipette) on to an ordinary slide. To this is added a drop of *Proteus* OX19 antigen, which was shaken gently before

using. The mixture of serum and antigen thus prepared on the slide is mixed thoroughly with a separate toothpick or with the tip of the capillary pipette. For each test a fresh pipette not previously in contact with another serum, is used. Each day a control is set up on a glass slide, using, instead of serum, a drop of normal salt solution. After mixing, the glass slide is gently rocked back and forth ten to twenty times, and during this rocking the slide is studied carefully for the appearance of the clumping. In cases in which a marked agglutination will occur, the clumping is observed, with the naked eye, after ten to thirty seconds; seldom is it necessary to wait as long as one or two minutes. The longer times were required especially in rare so-called "false positives." Usually it was not necessary to observe the glass slide under the microscope (with low power); only in a few doubtful cases, particularly in cases of a slow belated agglutination in the "false positive" tests, did we make the observation with the aid of the microscope, in order to check on the appearance of clumping. In several cases of very early pregnancy, in which we had a very slow clumping, we were compelled to use the microscope in order to determine whether the clumping of the organisms did occur; a week or so later, however, as pregnancy advanced, the sera of the same patients agglutinated the *Proteus* OX19 in about twenty seconds and the agglutination was easily visible with the naked eye.

The results of 1,212 tests made on the sera of men and women are summarized in Table I.

* Aided by Constantine Hering Fund of the Hahnemann Medical College of Philadelphia.

TABLE I
ANALYSIS OF 1212 TESTS ON SERA OF MEN AND WOMEN

	Men	Women
Total sera examined....	412	800
Negative results.....	390	288 (nonpregnant)
Positive results.....	22 { Tumor—2 Vaccinated with Bacillus proteus vulgaris—2 Unknown cause—18	512 { Pregnant—505 Nonpregnant but with tumors—7

Note that the test was 100 per cent positive in pregnant women, and that positive tests for nonpregnant women were obtained only in cases with certain malignant tumors.

Of the 412 sera taken from men, 390 gave a negative agglutination test, while twenty-two gave a positive test. Of these twenty-two positive cases in men, two were affected with carcinoma; two had previously received injections of an autogenous vaccine prepared from a strain of *Bacillus proteus vulgaris* isolated from their feces. We have thus far not been able to complete a detailed and reliable enough investigation in order to reach a satisfactory explanation for the positive results obtained for the eighteen men listed in the Table 1 as "unknown cause."

The group of 800 women gave 288 negative tests (in nonpregnant women) and 512 positive; of these 512 cases, only seven were not pregnant, *but all seven (as also in the cases of the two men mentioned above) were affected with a malignant tumor.* This fact, incidentally, is of an interest and we plan in the future to investigate this problem more exhaustively, namely, the agglutination of *Proteus OX19* by blood sera of patients affected with malignant tumor, in order to obtain statistical data, which would enable us to reach some reliable conclusions as to the value of this test in the diagnosis of tumors.

All the 505 pregnant women, i.e., 100 per cent of the pregnant cases examined, gave a positive test.

We wished also to determine the dilution titer of the sera which agglutinated the different strains OX of the *Bacillus proteus*. After a few experiments with other strains, which gave no clear-cut results, we decided

to use only the strain OX19. We followed the standard technic as shown in Table 11. For each specimen of blood serum we used ten dilutions in a series of ten ordinary agglutination tubes, plus one (the eleventh) tube for control. In each tube, with the usual technic, we placed sterile normal salt solution, plus a suspension in salt solution of *Proteus OX19* (obtained from the "American type culture collection"), plus the serum to test (diluted according to standard technic); in the eleventh (the control) there was of course no serum, but only the salt solution and the suspension of the *Proteus OX19*. The suspension of the latter was always adjusted roughly to the same bacterial density by inspection of the turbidity. After incubation at 37°C. for two hours, the agglutination tubes were placed in a refrigerator overnight, and the following morning the results were read.

Owing to lack of time, the titer of the agglutinins was not determined for each of the 505 positive cases. Such a more complete and detailed study is planned for the future. We did, however, determine the titer for some fifty sera; and the titer which we found ranged between a minimum of 1:256 (Case of Mrs. I.) and a maximum of 1:1024 (Case M. Y.). (Table 11.)

For the same reason we could not establish the stage of pregnancy in which our test first begins to yield a positive result, nor could we determine how soon after delivery (or after abortion) the test becomes negative. There are important aspects of this test which we plan to investigate more exhaustively. But we have at least presumptive evidence that the positive test appears at a very early stage of pregnancy. Thus, for example, in Case No. 1201 (M. Y.) the diagnosis of pregnancy was difficult and complicated because of some unusual features. The patient was a twelve year old girl, and our test was weakly positive, whereas the Friedman pregnancy test was negative. Twelve days later, when the Friedman test became positive, we repeated our test with a fresh specimen of blood serum and then our test

showed a strongly positive result and agglutinated even at a dilution of 1:1024. (Table II.)

office of the physician while he continues his examination of the patient.

In certain cases our test could supple-

TABLE II

	1	2	3	4	5	6	7	8	9	10	11 Control
	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	1:2048	
Case No. 140.....	+++	+++	++	++	+	+	+	+	-	-	-
Case No. 161.....	+++	+++	+++	++	+	+	+	±	-	-	-
Case No. 162.....	+++	+++	+++	+++	++	+	+	±	-	-	-
Case No. 520.....	+++	+++	+++	++	+	+	+	+	±	-	-
Case Mrs. E. C.....	+++	+++	+++	++	+	+	+	±	-	-	-
Case Mrs. I.....	+++	+++	+++	++	+	+	+	-	-	-	-
Case M. Y. No. 1201.....	+++	+++	+++	+++	+++	++	++	+	+	-	-
Case No. 977.....	+++	+++	++	+	+	+	+	-	-	-	-

Although we obtained 100 per cent positive reactions in all cases of pregnancy tested, we do not claim to have elaborated a new pregnancy test, or a better test than those that already exist and are used routinely. The accumulation of further data would place the test on a firmer statistical basis. For this reason we hope that other investigators will further extend the number of cases studied by this method for the diagnosis of pregnancy. Additional work is necessary also to determine the limitations of the test, the conditions which may increase or decrease the intensity of the reaction, and to inquire into the numerous problems which suggest themselves as a result of this initial investigation.

On the other hand, if this test is confirmed and its utility checked by other workers it would be of value as a test possessing certain material advantages over the best tests that exist today for the laboratory diagnosis of pregnancy, such as the Friedman test^{1,2} or its modifications by Reinhart and Scott^{3,4} or by Schneider.⁵ This could be so because, technically at least, our test is a simple, quick and easy one, utilizing a technic which does not require a highly specialized training, and can be performed in any medical office or dispensary, without calling for special apparatus, and may be carried out in the

ment the Friedman test, namely, in case of a "doubtful" Friedman test which happened, for example, in our Case No. 1201 (M. Y.) in which the Friedman test was negative, whereas our test was positive.

An obstacle which certainly will handicap the routine use of our test presents itself in the shape of the so-called "false positive." This is due to the fact that weak cross agglutinations occur with some sera, because strains of *Proteus* are capable of causing infections of the urinary tract and of the ear^{6,7} and also infections of the gastrointestinal tract⁸ and so give rise to agglutinins for *Proteus*. This may possibly explain the occurrence of our "false positives" in the group of eighteen men.

Remaining also is the fact that our test gives a positive reaction in certain cases of malignant tumor (carcinoma). This is suggestive of the possible use of the test as an aid in diagnosing cases of malignancy. Yet at the same time it renders our test somewhat less "specific" for the diagnosis of pregnancy. It is also recognized that other pregnancy tests as well are complicated by conditions which give rise to "false positives," e.g., the Aschheim-Zondek test is positive in cases of hydatiform mole and in chorionepithelioma;⁹ with Friedman and Schneider tests "false positives" have been obtained in association

with tuberculosis of the adnexae, with persistent corpus luteum cysts combined with amenorrhea, hyperthyroidism and certain diseases of the hypophysis."¹⁰ Teratomas, especially in the gonads, may give a false positive reaction in both men and women.^{10,11}

Therefore, no matter which test we use in making a diagnosis of pregnancy today, we cannot dispense with the clinical and physical diagnosis.

In any case, the fact that the blood sera of 505 pregnant women, without exception, agglutinated the Proteus OX19, is of sufficient importance from a scientific standpoint to challenge the curiosity not only of the immunologist but also of students in related fields: physiologists, obstetricians, endocrinologists, and even epidemiologists. In fact, in the case of an epidemiological survey in any given area having to do with the incidence of the rickettsia diseases, we have to be aware of the factors discussed above which would necessarily complicate the results of the survey. A positive result in testing for the presence of agglutinins for Proteus OX19 in certain sera might not necessarily mean the prior existence of a rickettsia infection, but might also indicate pregnancy, a malignancy, or other conditions alluded to earlier in this paper.

SUMMARY

Examinations were made of 1,212 sera of men and women for the agglutination of Proteus OX19. Of the 412 sera taken from men, 390 did not agglutinate, while twenty-two did agglutinate the Proteus OX19.

In the group of 800 sera from women, 288

nonpregnant women gave negative tests, whereas 512 sera gave positive tests. Of these 512 cases, only seven women were not pregnant, but all seven were affected with a malignant tumor. *The remaining 505 sera were taken from pregnant women, and all gave positive agglutination tests for Proteus OX19.*

The value of the test for the routine diagnosis of pregnancy is discussed, as well as the possible reasons for the positive results which were encountered in the cases of malignancy and other complications.

REFERENCES

1. FRIEDMAN, M. H. Mechanism of ovulation in the rabbit. II. Ovulation produced by the injection of urine from pregnant women. *Am. J. Physiol.*, 90: 617-622, 1929.
2. FRIEDMAN and LAPIAVI. *Am. J. Obst. & Gynec.*, 21: 405, 1931.
3. REINHART, H. L. and SCOTT, E. The hormone test for pregnancy. *Am. J. Clin. Path.*, 1: 113-126, 1931.
4. REINHART, H. L. The results of two years' experience with the Friedman test. *Am. J. Clin. Path.*, 3: 9-15, 1933.
5. SCHNEIDER, P. F. A hormone test of early pregnancy. *Surg., Gynec. & Obst.*, 52: 50-60, 1931.
6. WELCH, H. and POOLE, A. K. *J. Bact.*, 28: 523, 1934.
7. WELCH, H., MICKLE, F. L. and BORMAN, E. K. *Am. J. Pub. Health*, 24: 1157, 1934.
8. AZZI, A. *Microbiologia e Immunologia*. Vol. 2, p. 660. Milan, 1938. Casa Editrice Dr. F. Vallardi, Milan.
9. ASCHHEIM, S. The early diagnosis of pregnancy, chorion-epithelioma, and hydatiform mole by the Aschheim-Zondek test. *Am. J. Obst. & Gynec.*, 19: 335-343, 1930.
10. ALLEN, BANFORTH, DOISY. *Sex and Internal Secretions*. 2nd ed., pp. 1297-1301. Baltimore, 1939. Williams and Wilkins Company.
11. FERGUSON, R. S. Pathologic physiology of teratoma testis. *J. A. M. A.*, 101: 1267, 1933. (Abstracted from *American J. of Cancer*, N. Y.; 18: 269, 1933.)



COMPARISON OF TISSUE REACTIONS FROM NEW SUTURES*

OCTAVUS P. LARGE, M.D.

PHILADELPHIA, PENNSYLVANIA

THE development of metallic sutures through the centuries is very interesting. In the sixteenth century Hieronymus, a teacher of Sir Wm. Harvey, wrote of the advantages of gold wire in surgical practice for ligation of vessels. Henry S. Levert,²⁵ of Alabama, in 1829, reported a series of twenty-one experiments upon dogs ligating the carotid and femoral vessels with lead, platinum, silver, waxed silk and gum elastic resin. Of these experiments the metallic sutures showed the least reaction. Some years before, Dr. Physick had suggested lead as suture material because of the minimal tissue reaction about missiles implanted in the tissues of the body resulting from war wounds.

J. P. Mettauer, of Virginia, aware of the reports and suggestions of Levert and Physick, closed vesicovaginal fistulas using lead wire in six cases. Mettauer's instruments and wire may be seen in the Mutter Museum in Philadelphia. The real pioneer use of metallic sutures should be credited to J. Marion Sims³⁰ who disheartened and "studiously avoiding," after many trials and failures to close vesicovaginal fistulas, turned to the use of silver wire. On November 14, 1848, with the aid of jeweller, blacksmith, and dentist he assembled the instruments to perform his first successful closure of a vesicovaginal fistula upon a Negro patient who had had thirty previous attempts. His description of the cure of this patient imparts his real joy and enthusiasm. He converted a small house into a hospital for these unfortunate patients. It is said he closed over 200 vesicovaginal fistulas.

J. Y. Simpson, of Edinburgh, in 1858, continued the use of metallic sutures, after

having attended a lecture given by Dr. Bozeman (Assistant of Sims) relating the successes with silver sutures.

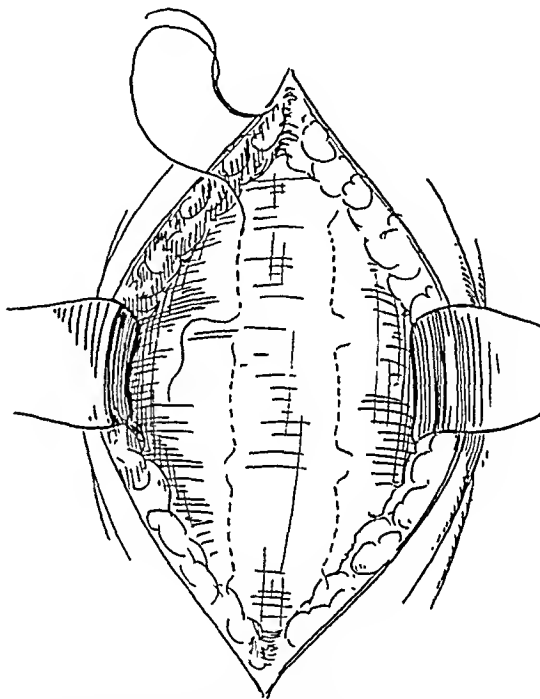


FIG. 1. Illustrates placement of sutures in rectus muscle of a dog. Note there is no constriction of tissues.

In 1904, Dr. W. W. Babcock,³ following Bartlett,⁶ first attempted to close large defects in the abdominal walls by imbedding a fine silver wire filagree. Babcock, finding that the silver filagree became fragmented from movements of the body, introduced (1916) a fine sterling silver chain as employed by jewelers. In 1932, Babcock turned to alloy stainless steel wire which proved to be superior to silver wire. At first it was implanted in the skin and allowed to remain for weeks to note the reaction. The surprising absence of necrosis or suppuration encouraged Babcock

* From the Department of Surgery, Temple University Hospital, Philadelphia.

to use it as a buried suture, where it has surpassed any previous absorbable or nonabsorbable sutures.

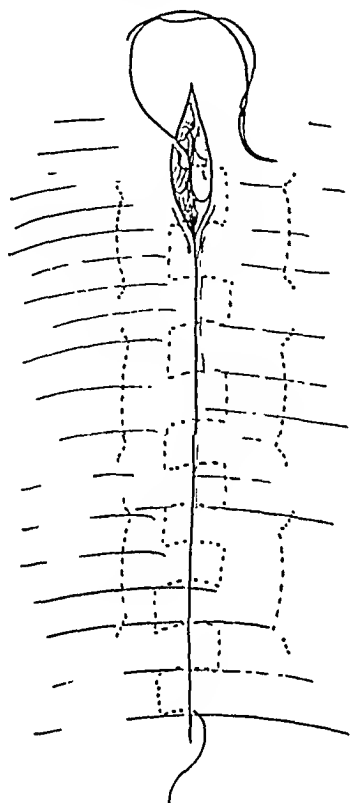


FIG. 2. Subcuticular closure of abdominal skin.

In an effort to be impartial in judging the most ideal suture for general use, the research department* for the past four years, has been comparing and testing new sutures. Preston, in 1939, reported his results in a comparison of the tensile strength of wounds united with wire and other commonly used sutures. He showed the superiority of the tensile strength of wounds closed with the stainless steel all wire technic. My efforts have been confined to the microscopic comparison of alloy steel wire with other sutures.

Clinical experiences gained by observing skin reactions from various sutures in over one-hundred patients, and in reopened abdominal wounds at varying periods of time, have prompted further animal experimentation and microscopic study. The

* Department of Surgical Research, Temple University Hospital.

degree and type of reaction is influenced by many factors: (1) Number and type of organisms present at the time of the sutur-

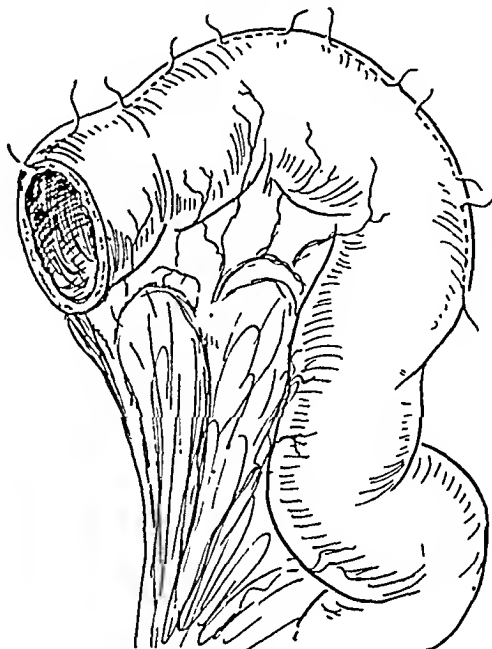


FIG. 3. Placement of sutures in muscular coat of ileum, without perforating mucous membrane.

ing; (2) vascularity: an organ or tissue with impaired blood supply either from pathologic process or from constricting sutures or ligatures will naturally show marked reactions; (3) nutrition: weak and debilitated patients with long standing infections, systemic disease, avitaminosis and hypoproteinemia may show delayed healing. The influence of the general systemic condition of the patient upon healing has been very definitely shown by the researches upon hypoproteinemia and vitamin c; (4) foreign bodies other than sutures will prevent normal wound healing and finally allow organisms to invade the subcutaneous tissues and proliferate, causing infection and suppuration. Blood, serum, and bile, when permitted to diffuse through tissues, act as culture media and prevent accurate co-aptation of the wound edges. Hemostasis favors primary healing, especially if the tissues are potentially infected. Nevertheless, these local and systemic factors are too often believed

to be the cause of wound disruptions, infections, and eviscerations, when the use of the suture material and the technic used are at fault.

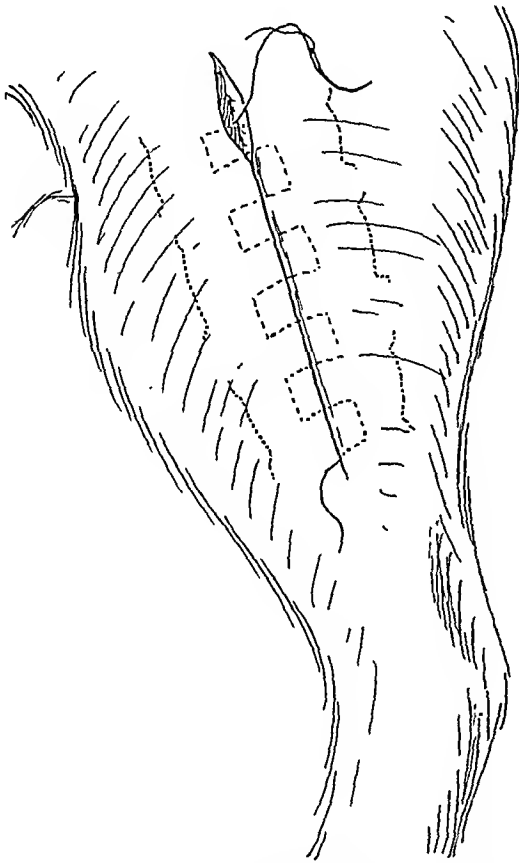


FIG. 4. Placement of sutures in quadriceps muscle of a dog.

The prerequisites for an ideal suture have been clearly and repeatedly set forth, but tissue reactivity should be the cardinal factor in choice of the ideal suture material. Halsted¹⁵ believed, "the merits of sutures should be based entirely upon the reactivity in tissues, wound strength and ease with which they can be handled." By tissue reaction we mean the type and degree of response of various tissues to a foreign body. Nonirritating sutures will not induce the inflammatory changes which retard wound healing. Sutures causing the least reaction facilitate wound healing by reducing the inflammatory changes. Nevertheless, catgut, which causes the greatest reaction, is still the suture of choice, but the trend is changing to nonirritating sutures.

WOUND HEALING

Wound healing has been divided into two stages: (1) exudative or latent period,



FIG. 5. Alloy steel 18-8 wire No. 36 in subcutaneous tissue three weeks. A, orifice through which the suture passed with the minimal amount of leucocytes and fibroblastic reaction in a surrounding zone. All microphotographs were taken of tissue from same dog and at same magnification.

so-called lag-period; (2) reparative or fibroplastic period (Howes,¹⁷ Arey¹). The exudative or destructive stage includes chiefly lysis of cells and absorption of exudates. Autolysis and heterolysis is the chief function of the neutrophils during the latent period, lasting from one to two days. The constructive changes are instituted by those cells which are commonly found in connective tissue, amoeboid cells, fixed macrophages, fibroblasts and mesenchymal cells. Catgut wounds have a longer latent or lag-period, lasting from four to eight days. There is a definite relationship between the microscopic picture of healing and the strength of the wounds, i.e., they are inversely proportional, the greater the

reaction the weaker the wound. Wound disruptions following the use of catgut are not due to its absorbability (Howes¹⁸). It

ach was carried out with routine aseptic technic, precautions being taken to reduce the possibility of infection. A vertical mid-

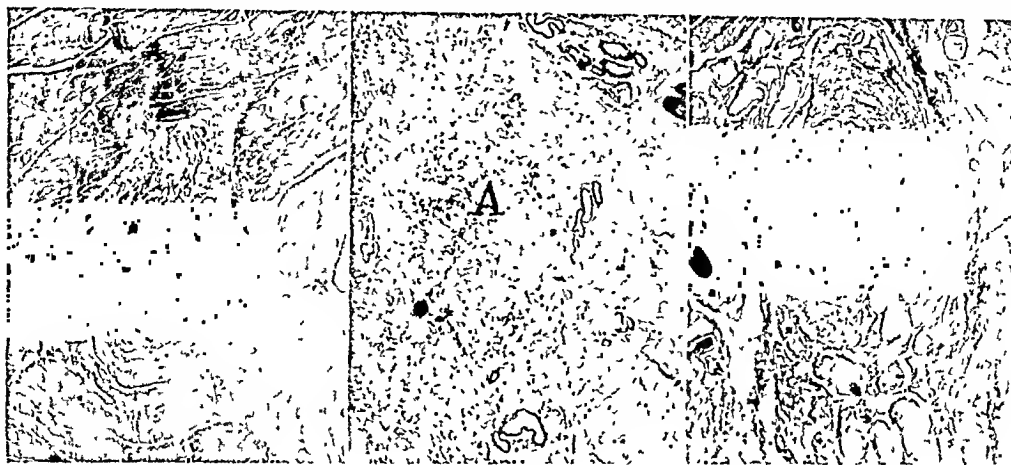


FIG. 6.

FIG. 7.

FIG. 8.

FIG. 6. Alloy stainless steel No. 36 in quadriceps muscle three weeks, showing mild cellular reaction occurring in intermuscular septum.

FIG. 7. Alloy steel No. 36 subcutaneous tissue three weeks. A, indicates suture site showing the least reaction of any sutures tested.

FIG. 8. Silk untreated three weeks showing the cellular infiltration surrounded by normal muscle.

has been shown that disruptions usually occur before the suture has been absorbed (Botsfords⁹). Wound healing in the early stages is really a specialized manifestation of the general process of inflammation leading to provisional closing with fibrin which forms a substrata for the invading connective tissue cells (Arey¹).

In attempting to find an ideal suture material we have compared the tissue reactions of nylon, zytol, catgut, plastigut, glass thread, plain spool silk, treated silk annealed 18-8, stainless wire and cotton.

Twenty-five experiments were performed on ten dogs and three rabbits. The dogs were the same sex, age, and weight, free from any disease or skin infection. Intravenous anesthesia of pentobarbital sodium was used in proportion of 1 gr. per cc. per kilo of body weight for two-hour anesthesia, average dose being 5 to 10 cc. for the dogs.

The skin of the anterior abdominal wall was shaved, washed with tincture of green soap and ether, and finally painted with tincture of mercuric chloride. Implantation of the various sutures in the rectus muscle, quadriceps, unopened intestine, and stom-

line incision was made through the skin. The subcutaneous tissues were liberated from the anterior sheath of rectus and from the quadriceps muscle, well to the side of the incision. The six types of sutures used for comparison were of the finer sizes: catgut No. 000, nylon No. 000000 and No. 000, cotton No. 50, stainless steel No. 38, plastigut No. 0000, silk No. 1. These sutures were placed in the same tissue of each animal, with the same size curved needle, no ties or ligatures being used which might constrict or interfere with wound healing or cause irritation. This method reduces any of the external factors which may influence the results. A subcuticular stitch of suture material being tested was used to unite the wound edges. With the buried suture there was no tendency for the animals to pull, bite or lick the wound. No dressings were applied to the wounds of any animal. They were replaced in the usual cage and given the usual diets. On the sixth and twentieth postoperative days under nembutal anesthesia and with aseptic, the wounds were reopened and a wide ellipse of tissue was removed, including the test suture which had not been disturbed.

These were sent for microscopic sections. The incision was resutured and the animal used for other experiments. Before cutting

and in potentially infected wounds. The alloy stainless steel suture gave the least reaction of any tested. The reaction in the

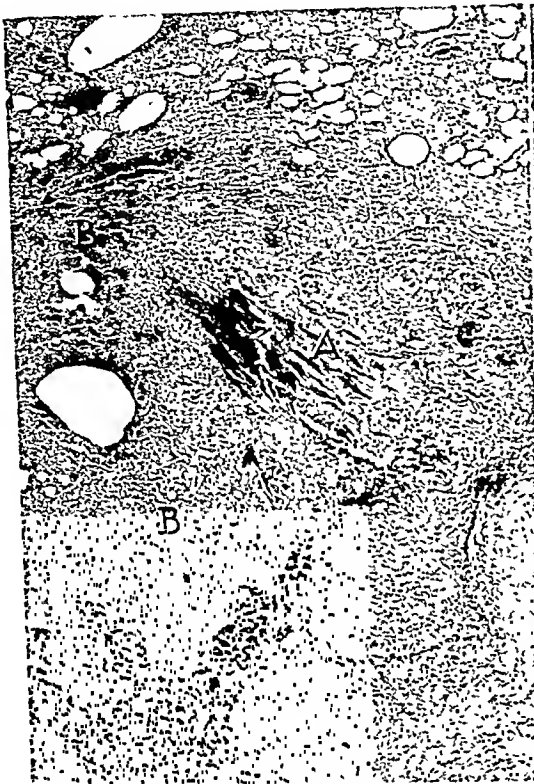


FIG. 9. Fine waxed silk in subcutaneous tissue three weeks. A, indicates the strands of silk; B, surrounded by intense foreign body cellular reaction, showing infiltration of polymorphonuclear leucocytes and lymphocytes with beginning necrosis and supuration.



FIG. 10. Cotton No. 40 in subcutaneous tissue three weeks. A, is suture site; B, shows the marked fibroblastic reaction with minimal leukocytic infiltration.

the sections, sutures that would damage the microtome knife were removed. It became evident after several experiments that the reaction of tissues followed a definite curve over varying periods of time. The majority of reactions became pronounced from the fourth to the eighth day, then subsided by the end of the third week; hence, the reason for taking sections on the sixth and the twentieth days. (Fig. 1-4.)

DISCUSSION

The quadriceps and rectus muscles seemed the ideal site for testing sutures. In these muscles possible infection from skin or intestinal flora was eliminated. The reactions occurring in the muscle sections were duplicated in other tissues of the body

skin was practically nil. In the muscle there was absence of cellular, fibroblastic and edematous reaction about the suture which is so characteristic with catgut. In the intestine the degree of reaction was similar to silk. Stainless steel wire facilitates primary healing by causing a minimal amount of reaction, no capillarity and none of the usual inflammatory signs seen in the latent period. These findings have been confirmed by others experimenting with sutures. Bellas⁷ states that "alloy wire makes the closest approach to the ideal suture." His objections are radio-opacity and difficulty of surgical manipulation. Bothe, Beaton and Davenport,⁸ from careful experiments with bone implants gave stainless steel, vitallium, and titanium the zero positions on the scale of bone reactions. Farris,¹³ by his ingenious method

of testing sutures in the anterior chamber of the rabbit's eye, states that he could scarcely measure the reaction of stainless

the exudative phase and retard the normal reparative phase of wound healing.

Nylon is a synthetic polymer, derived

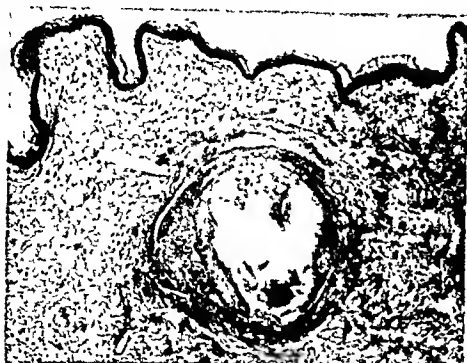


FIG. 11. Nylon 4-0, four weeks in subcutaneous tissue showing visible strands of nylon surrounded by leukocytes and lined by squamous epithelium.

steel wire. Babcock,⁵ Jenkins,²² T. Jones²³ and many others have shown clinically that stainless steel sutures have given a minimum of tissue reaction with a maximum of wound strength from the very first postoperative day. Microscopic studies confirm the results. (Fig. 5.)

Cotton and plain spool silk led to reactions of considerably less intensity than catgut, nylon or plastigut. (Figs. 9 and 10.) These sections were characterized by a small zone of leukocytic and round cell infiltration increasing up to the eighth day when fibroblastic replacement begins and reaches a maximum in the third to fourth week. Cotton has greater tensile strength than silk of equal size, especially after the sutures had been boiled several times. Boiling of cotton tends to increase the strength rather than weaken it. The addition of wax or other organic substance to increase the strength of sutures increases the reaction in the tissues. There was a greater area of inflammatory reaction especially of the highly cellular type. After two weeks, however, the reactions were quite similar. Organic substances and dyes used in the processing of sutures may increase the degree of reaction, which is inversely proportional to the wound strength during the first two weeks of healing. These organic and synthetic compounds prolong



FIG. 12. Plastigut 000. in subcutaneous tissue after three weeks. A, opening through which the suture passed; B, showing the hyalinization about the suture; C, indicates the marked fibrotic reaction with surrounding dense layer of fibroblasts with only a few leucocytes next to suture opening.

from the chemical union of diamine and a dicarboxylic acid (Aries). (Fig. 11.) The organic composition of the suture explains the reason for its rather intense tissue reaction. The microscope revealed a very highly cellular type of reaction consisting of a wide zone of round cells and polymorphonuclear leukocytes, serum, giant cells during the first week and small areas of fibroblasts which gradually increase as the cellular reaction decreases. Finally, in three weeks fibroblasts predominated and the wound went into the reparative stage of healing. Epithelization of the squamous cell type was found to line the canal through which the sutures passed in the third week. Nylon seemed to favor or hasten epithelization. In many types of

wounds this characteristic is very desirable. Similarly with catgut and plastigut, the latent or lag-period was greatly increased

blasts, many lying parallel to each other, long spindle type cells with only an occasional lymphocyte or polymorphonuclear



FIG. 13. Plastigut three weeks in quadriceps muscle showing extensive fibroblastic reaction surrounded by normal muscle fibers. All microphotographs taken with same magnification.

over the inorganic sutures, i.e., stainless steel and glass. Nylon, which has been treated with different vegetable dyes and marketed by various trade names, causes equally severe reaction in the clean as in the potentially infected wounds. In the skin a reaction measured 1 cm. in diameter and consisted of indurated friable inflammatory tissue which lasted for two weeks. There was no difference noted in reaction of the mono or multifilament nylon sutures. Further experiments are being carried out to determine if the untreated plain nylon gives less reaction than the treated varieties.

Plastigut is said to be composed of "incorporated synthetic materials especially selected; they are polymerized condensation products of aliphatic and aromatic alcohols and aldehydes." (Fig. 12.) The reaction was marked in comparison with other sutures tested, showing more fibroblastic reaction. The histologic picture with *plastigut* was unusual and quite characteristic. The opening through which the suture passed was surrounded by whirls of fibro-



FIG. 14. Catgut No. 00 plain in subcutaneous tissue three weeks. A, shows channel through which suture passed; B, surrounding severe foreign body reaction of cellular type. Marked leukocytic infiltration, beginning necrosis and suppuration.

leukocyte. The reaction was very striking during the first week beginning as a cellular type in the brief destructive phase, rapidly changing to the fibroplasia which invaded the wound edges. This reaction continued until the third week when it gradually subsided. The extensive reaction, however, does not indicate strength in wound healing as demonstrated by Preston,²⁰ Haines, Aries and others. However, this type of reaction may have a definite place where fibroblast is desirable; for example, cellophane wrapped loosely about a dog's kidney produces a severe fibroblastic reaction which compressed the kidney to such an extent that hypertension was produced. We have been able to obliterate the femoral artery of a dog by loosely wrapping a roll of cellophane or *plastigut* 12 mm. wide

about the artery. Microscopic section shows the arterial wall to be three times the thickness and almost completely oc-



FIG. 15. Silk untreated two weeks with visible strands of silk in muscularis coat of the stomach surrounded by zone of leukocytic infiltration with beginning fibroplasia in periphery.

cluded by the fibroblastic reaction. (Fig. 13.)

Catgut, plain or chromic, produced the greatest reaction in comparison with stainless steel, silk, cotton, nylon and plastigut. (Fig. 14.) The anastomoses and wounds sutured with catgut were the weakest. The tissue through which it passed showed all signs of foreign body reaction from the fourth day until the catgut was absorbed. The reactions from chromic and plain catgut were highly cellular with a prolonged destructive phase characterized by giant cells, polymorphonuclear leukocytes and round cells; in many sections the central zone of reaction revealed loss of cell structure and beginning necrosis. The segments of catgut placed in muscle did not become infected but those in skin and intestine did show evidence of infection and sinus formation with spread of infection along the suture by capillarity. From these observations it would appear that patients whose wounds have been united with catgut are allowed out of bed when their wounds are the weakest, from the

seventh to the fourteenth day, during the lag-period. In contrast, however, stainless steel which causes practically no reaction allows for early reparative phase. Clinically, this statement has been verified by those advocates of stainless steel. Babcock has had only one evisceration in the last 500 cases; this includes all types of abdominal surgery. Jones²³ has reduced his percentage of wound infection from 27 per cent in intestinal resection for carcinoma to 0.85 per cent by changing to all wire technic in the last 116 cases.

The *glass thread* was very difficult to handle, being very friable and easily broken at the eye of the needle. Experiments upon this type were abandoned for this reason, although placed in the skin of the abdominal wall it caused practically no reaction. The very fine fibers making up the thread frayed out and were difficult to remove from the wound.

The anastomosis performed between stomach, gallbladder, jejunum and ileum by the usual technic presented very interesting gross and microscopic findings. The experiment was directed toward a definite comparison of merits of the two most common sutures used for such anastomoses, namely, silk and catgut, with stainless steel. The anastomosis in which catgut or silk was used for seroserous suture (outer row) showed numerous dense vascular adhesions between liver, spleen and adjacent loops of intestine at the end of two weeks. Those anastomoses in which all wire technic was used or No. 36 wire alloy was used for outer row of seroserous interrupted suture were free from any gross evidence of adhesions or reaction. (Figs. 6 and 7.) As pointed out by Aries and others, continuous sutures in anastomoses of any type increases the danger, morbidity and mortality from the operation, by obstructing the lumen and increasing the bulk of strangled avascular tissue which becomes necrotic and sloughs into the lumen of the intestine. From our observations, however, accurate union of serous surfaces of the bowel by stainless steel alloy

is a desirable part of the anastomosis. The all steel suture technic gave minimal amount of reaction. The plain spool silk gave considerably less reaction than the waxed or treated type, again emphasizing the fact that organic substances as wax, oil, vaseline, etc., cause severe reactions. In one dog a piece of vaseline gauze was placed in the peritoneal cavity for ten days to see what reaction might occur when vaseline gauze is used for drains and packing. In ten days the gauze was encased in an inflammatory mass measuring 5 cm. in diameter, which had ulcerated through adherent ileum except for a very thin mucous surface. From our experiments the untreated sutures give the least reaction but are weaker in tensile strength. (Figs. 8 and 15.) The anastomoses in which catgut was used followed the usual type of dense inflammatory foreign protein reaction. These adhesions were noted when the anastomoses were examined at one, two and three week intervals.

SUMMARY

These animal experiments have shown that alloy steel metallic sutures give the minimal of reaction with maximum of tensile strength of wound. Cotton, silk (plain or waxed), plastigut, nylon and catgut show increasing degrees of reactions in the order mentioned. Plastigut shows excess fibrosis, while nylon stimulates epithelization, or proliferation of squamous

cells in tissues through which the suture passed. Intestinal anastomoses using alloy steel wire as an interrupted seroserous suture gave practically no reaction and were free of adhesions at the end of two weeks.

REFERENCES

1. AREY. *Physiol. Rev.*, 16: 327, 1936.
2. ARIES. *Surgery*, 9: 51, 1941.
3. BABCOCK. *Am. J. Obst. & Dis. Child.*, 74: 4, 1916.
4. BABCOCK. *Am. J. Surg.*, 27: 67-70, 1935.
5. BABCOCK. *J. A. M. A.*, 102: 756, 1934.
6. BARTLETT. *Ann. Surg.*, July, 1903.
7. BELLAS. *Arch. Surg.*, 41: 1414, 1940.
8. BOTHE, BEATON and DAVENPORT. *Surg., Gynec. & Obst.*, 71: 598, 1940.
9. BOTSFORDS. *Surg., Gynec. & Obst.*, 72: 690, 1941.
10. CALLER. *Ann. Surg.*, August, 1940.
11. COLP. *Ann. Surg.*, 99: 14, 1934.
12. ELKIN, DANIEL C. *Ann. Surg.*, 112: 280, 1940.
13. FARRIS. *Ann. Surg.*, 114: 1, 1941.
14. GLENN. *Surg., Gynec. & Obst.*, 65: 16, 1937.
15. HALSTED. *J. A. M. A.*, 60: 1119, 1913.
16. HOLLMAN. *Surg., Gynec. & Obst.*, 72: 1052, 1941.
17. HOWES. *Surg., Gynec. & Obst.*, 57: 309, 1933.
18. HOWES. *Surg., Gynec. & Obst.*, 73: 319, 1933.
19. HOWES. *Surgery*, 7: 24, 1940.
20. HOWES, SOOY and HARVEY. *J. A. M. A.*, 92: 42, 1929.
21. HUNT, ALLEN H. *Brit. J. Surg.*, 28: 436-461, 1941.
22. JENKINS. *Surg., Gynec. & Obst.*, 64: 648, 1937.
23. JONES, T. *Surg., Gynec. & Obst.*, 72: 1056, 1941.
24. KRAISSEL. *Surg., Gynec. & Obst.*, 63: 561, 1936.
25. LEVERT, HENRY S. *Am. J. M. Sc.*, 4: 17, 1829.
26. LUND. *J. A. M. A.*, 116: 663, 1941.
27. MELENEY. *Ann. Surg.*, 98: 151, 1933.
28. OSCHNER. *Surgery*, 7: 485, 1940.
29. PRESTON. *Am. J. Surg.*, 49: 56, 1940.
30. SIMS, J. MARION. Use of silver wire. Lecture at N. Y. Acad. of Med., Nov. 8, 1857.
31. WHIPPLE. *Ann. Surg.*, 112: 48, 1940.
32. WHIPPLE. *Ann. Surg.*, 108: 741, 1938.
33. WHIPPLE. *Internat. Abstr. Surg.*, 69: 109, 1939.



Case Reports

INSTRUMENTAL INTESTINAL TRAUMA DURING LAPAROTOMY

SPONGE AND TISSUE FORCEPS INJURIES

HARRISON S. MARTLAND, M.D.

Chief Medical Examiner of Essex County

NEWARK, NEW JERSEY

IN the course of medicolegal postmortem examinations, the author has recently encountered two instances of severe trauma to the small intestine. These injuries were caused by repeated compression of the intestine by "loop sponge holding forceps" and "Babcock tissue forceps." In each instance these unfortunate complications occurred during the course of an exploratory laparotomy.

In a large autopsy experience, consisting of both medicolegal and permission autopsies, and extending over a period of many years, the author has never observed this type of intestinal injury.

However, since the findings may serve to re-emphasize the danger of undue and rough handling of tissues, it is believed that the following observations should be recorded. Personal inquiry amongst numerous surgeons has elicited the response that they had neither seen nor heard of similar injuries, and except for the possibility of tearing free a "red hot appendix" in a Babcock forceps, none had realized the damage which might result from the use of an instrument in a manner which apparently is very common amongst surgeons.

The operating surgeon, in both above noted instances, was very competent and well above average in his knowledge and application of operative technic. It is most interesting to note that one surgeon after his attention has been called to the intestinal injuries, related that occasionally after

laparotomy (in which no work has been done on the gastrointestinal tract) the nurse's observations would record the presence of some blood in the stool. This soon disappeared and no particular attention apparently was paid to the possible significance of this observation.

CASE REPORTS

CASE 1. Trauma to small intestine by a loop sponge holding forceps, during laparotomy for supposed intestinal obstruction: death on operating table from hemorrhage and shock.

A female, colored, twenty-seven years old, was admitted to the hospital with a six-day history of nausea, vomiting and soreness in the epigastrium. Bilateral salpingectomy had been done three years ago. There was an indefinite history of recent treatment for syphilis.

The patient was observed for six days in the hospital during which her highest temperature was 101°F.; leucocytes, 6,000 per cu. mm. with 60 per cent polymorphonuclear leucocytes. A preoperative diagnosis of intestinal obstruction probably due to old adhesions was made. It is interesting that an intern had noted "impression not surgical" on the patient's chart. The patient complained of pruritus but though no dermatitis was noted, an arsphenamine reaction was suspected.

Operation was performed under open drop ether anesthesia. On opening the abdomen practically no gross pathological lesions were discovered. Volvulus was suspected since one segment of the intestine appeared to be somewhat discolored. The patient suddenly vomited and stopped breathing. Respiration was re-

stored and the appendix removed. The eviscerated intestine was then returned to the abdominal cavity by repeatedly grasping it

the intestine. Many of these occurred in pairs on each side of the intestine and showed typical "pattern marks" of the size and shape of the



FIG. 1. Case 1. Several loops of small intestine after removal at autopsy. The characteristic "pattern marks" made by the loop of the sponge holding forceps may be noted.

with a uterine, straight, loop, sponge holding forceps. This instrument was $9\frac{3}{4}$ inches long, had round shanks, smooth jaws and a *box lock*. The abdomen was closed in layers in the usual manner. At the end of the operation the patient again ceased breathing and all resuscitation methods were of no avail.

Essential autopsy findings were as follows: An obese, colored woman, 180 pounds in weight, who had a recent lower midline laparotomy wound. A faint odor of ether came from the mouth. There was a small amount of light red fluid blood in the right side of the heart, and a faint odor of ether on section of the lungs.

The abdominal cavity contained no free blood; the small intestines presented a remarkable appearance; starting 6 inches below the duodenojejunal angle there were about fifty areas of light and dark red hemorrhage in the wall of the intestine extending over most of

loop end of the sponge holder. This is positive proof that they were caused by the grasping forceps. Other marks were smaller and had no particular pattern.

The small intestine contained over 1,500 cc. of fluid blood in its lumen. The blood was found down to the ileocecal valve, with very little in the large intestine. Practically all the marks seen on the outside of the small intestine, extended through the entire gut wall and there was extensive submucosal and mucosal hemorrhages, often with fine linear laceration of the mucosa.

Both Fallopian tubes had been removed at a previous operation. The uterus was normal in size and appearance. Both ovaries were present and a recent corpus hemorrhagicum was observed in one. There was no gross evidence of syphilis and no significant pathological lesions in any of the other organs.

Comment. Since the lumen of the small intestine contained more than a quart and a half of blood, the cause of death was

forceps. This instrument had a smooth triangular end about three-eighths of an inch in width, and was fitted with a *box lock*.



FIG. 2. Case 1. The middle segment shows the small intestine from the serosal side. The segments on the right and left demonstrate the extension of the hemorrhages to the mucosa.

undoubtedly hemorrhage and shock. A complete autopsy, including microscopic and toxicological examinations, disclosed no other cause of death. (Figs. 1 and 2.)

CASE II. *Traumatism to small intestine caused by a Babcock tissue forceps, during laparotomy for an "acute surgical abdomen;" death one day later from hemorrhagic pancreatitis.*

A male, white, twenty-nine years of age, was admitted to the hospital complaining of peri-umbilical, right rectus and left lumbar pain of four days' duration. The pain was sharp, constant, and aggravated by eating. Vomiting afforded little relief, and for the last forty hours the patient had been vomiting continuously. Constipation was present for four days; temperature 101°F., pulse 96, respirations 24 on admission; systolic blood pressure 130, diastolic 112. Urine showed a two-plus albumin and one-plus sugar; hemoglobin 107 per cent, erythrocytes 6,430,000 per cu. mm.; leucocytes 16,200 with 80 per cent polymorphonuclear leucocytes.

A preoperative diagnosis of an acute surgical condition of the abdomen was made, probably due to intestinal obstruction caused by old adhesions resulting from an operation for gangrenous appendicitis.

On opening the abdomen, very little gross pathological disturbance was discovered and after breaking up a few old adhesions the intestines were returned to the abdomen by repeatedly grasping it with a Babcock tissue

The next day the patient was moribund. Temperature was 105°F., pulse 160 and respirations 50. He had had several convulsive seizures and death occurred twenty-four hours after operation.

Essential autopsy findings revealed the following: A well developed and nourished male body, about 180 pounds in weight. There was an old laparotomy scar in the right lower quadrant. The recent laparotomy wound in the left upper quadrant was covered by a surgical dressing.

There was extensive acute hemorrhagic pancreatitis involving the left half of the body and tail of pancreas with extensive necrosis, autolysis and hemorrhage. There was typical fat necrosis over the lesser abdominal sac, about the hilus of the spleen and along the mesenteric attachment of the descending colon, and a gaseous phlegmon running down over the left psoas muscle to the pelvic brim. Most of the general peritoneal cavity was normal and the lesion had apparently escaped the surgeon's detection.

The gallbladder and bile ducts were free of inflammation. The pancreatic ducts in the tail of the pancreas contained creamy pus.

Scattered over the small intestine were about forty hemorrhagic areas, similar to those seen in Case I, except that many were smaller in size and showed typical "pattern marks" of the size and shape of the end of the Babcock tissue forceps. Many marks extended through the thickness of the intestinal wall and could be



FIG. 3. Case 11. Several loops of small intestine after removal at autopsy. The characteristic "pattern marks" assuming the size and shape of the grasping end of the Babcock tissue forceps may be noted.

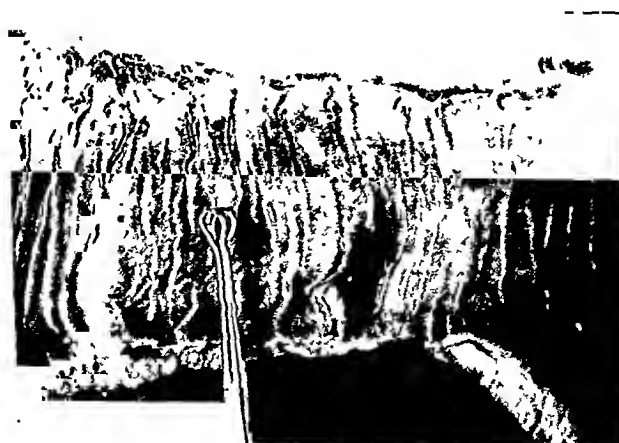


FIG. 4. Case 11. Interior of small intestine with marks of injury extending to the mucosa.

seen from the mucosal side. There was very little laceration of the mucosa and no gross blood was found in the lumen of the intestine.

Comment. The cause of death in this case is of course the acute hemorrhagic pancreatitis. Since there was no evidence of blood in the lumen of the gut we must conclude that the intestinal injuries did not influence or aggravate the primary clinical condition. (Figs. 3 and 4.)

CONCLUSIONS

Two cases of severe injury to the small intestine are reported. The injuries are due to the rather common practice of returning eviscerated intestines during laparotomy by grasping them with various types of instruments.

In the first case a loop sponge holding uterine forceps was used. This has a box lock and is able to exert great pressure. The surgeon unwittingly may have "clicked" it down to the lock on several occasions. If the use of such an instrument is necessary, could it not be covered with rubber tubing

of sufficient thickness to make it impossible to lock it? Or better still to have no ratchet or lock at all? This is a problem for the surgeon and instrument maker. Unfortunately, the intestinal hemorrhage caused by these forceps injuries caused death, since a careful autopsy ruled out any other cause.

In the second case, a Babcock tissue forceps was used. The injuries are similar to the first case but not so severe. This instrument also had a box lock. Since acute hemorrhagic pancreatitis is essentially a fatal disease, the injuries in this case did not apparently influence the outcome one way or another. In other circumstances, however, such injuries might seriously interfere with the postoperative convalescence.

It is quite possible that injuries of this type are much more common than one would suppose and since they frequently are not severe, the patient survives, and the cause of a stormy convalescence may be overlooked.

The importance of autopsies in fatalities after abdominal operations is emphasized.



WATER BLAST INJURY

REPORT OF TWO UNUSUAL CASES

COMDR. H. L. PUGH, M.C., U.S.N. AND LIEUT. R. M. JENSEN, M.C.-V(S) U.S.N.R.
PEARL HARBOR, T. H.

THE following cases illustrate several interesting surgical problems occurring in the course of blast injury to the abdomen. The first case demonstrates the ability of a sound physique to survive formidable surgical procedures and serious complications. The second case emphasizes the restorative powers of the human body when more conservative procedures are followed.

CASE REPORTS

R. L. S., a seaman second class, United States Navy, was admitted to the medical service of the Naval Hospital, Pearl Harbor, T. H. on June 9, 1942. His admitting diagnosis was compression injuries to abdomen and chest. He was critically ill and complained of pain in the right upper quadrant. His temperature was 100.8°F., pulse 124 and respirations were 28 a minute. Minimal dulness was noted over the left lung at the base, with suppression of breath sounds. The abdomen was markedly distended, tympanic and no peristalsis was noted.

Continuous nasal suction was instituted; 2,000 cc. of oily gastric contents were aspirated in the first twelve hours. Human plasma, glucose in saline and sodium sulfadiazine were administered intravenously with improvement. His abdomen became less distended, he was passing flatus and had a good urinary output. However, his temperature and pulse remained elevated (temperature 102° to 103°F. and pulse 130 to 150). The sulfadiazine level the following day was 37.2 mg. per cent.

A roentgenogram of the chest showed some infiltration in the left basal area peripherally and throughout the lower third of the right lung. On June 15th, a flat plate of the abdomen revealed many dilated loops of small bowel in the upper part of the abdomen having a "step-ladder" or "closed loop" appearance.

After consultation with the chief of the surgical service he was transferred to the surgical ward on this date.

A Miller-Abbott tube was introduced and approximately 1,500 cc. of greenish-brown intestinal contents were aspirated. An ampoule of prostigmine 1-2000 was given every four hours. The following morning the abdomen was soft, temperature was 99°F., pulse 124 and respirations 24.

Following plasma and whole citrated blood in addition to intravenous fluids he continued to improve although there was roentgenological evidence of gas in the mid-small intestinal lumen.

On the morning of July 2, 1942, twenty-three-days after admission this patient was seized with abdominal cramps and vomited his breakfast. He obtained partial relief of his symptoms. Examination revealed his skin to be cool and moist, temperature was 101°F. and pulse 120. Except for some abdominal distention examination including a rectal was negative. The leukocyte count was 24,650 and differential count showed 23 band forms and 67 segmented cells.

After preliminary preparation consisting of continuous nasal suction, whole citrated blood and intravenous glucose solution, the patient was explored under spinal anesthesia. A left mid-rectus incision was made. A volvulus of the first eighteen inches of the jejunum was found. There was tremendous distention and complete gangrenous change extending to within two inches of the ligament of Treitz. This loop of jejunum contained what was apparently an old perforation and was densely adherent to the parietal peritoneum opposite the left kidney.

The patient was in marked shock at the time of operation and received plasma, coramine and intravenous glucose, but as the volvulus was reduced he appeared to rally appreciably. Due to the condition of the patient this stage of operative intervention was concluded as expeditiously as possible. A segment of gangrenous jejunum about eighteen inches long was resected. A catheter was introduced into the proximal stump of jejunum and a second catheter was introduced into the distal segment

of the small bowel, both being brought to the outside.

The day following the operation, secretion from the upper loop was dripped into the lower loop through the tube in conjunction with a mixture of pabulum, egg, milk, gelatin, dextrose, orange juice and olive oil. Small repeated transfusions and intravenous plasma were used as supportive treatment.

On July 10, 1942, eight days following the resection a jejunojejunostomy was done under spinal anesthesia. By means of a Murphy button, the free ends of the jejunum were anastomosed. This was somewhat difficult due to the short proximal stump of jejunum, but was accomplished without incident.

On July 16, 1942, the edges of the wound separated exposing peritoneum and jejunum but with careful taping and vaseline gauze dressings the wound was allowed to granulate in from below.

The Murphy button was passed nine days after the jejunojejunostomy and the patient seemed well on the road to recovery. However, on the late afternoon of this day the patient suddenly developed respiratory difficulty and a slightly productive cough. He had no chest pain. Physical examination revealed temperature of 102°F., slight cyanosis (nails and cheeks), his pulse was 120 and numerous coarse râles could be heard on auscultation throughout both lung fields, but were more marked over the left base. Blood pressure was 120/60. A roentgenogram of the chest revealed cloudiness of the lung parenchyma of the left base. Leukocytes numbered 21,650. It was thought that he had a bronchopneumonia with associated acute pulmonary edema. He responded to adrenalin, aminophyllin and sulfathiazole. Oxygen was administered by tent. In five days his temperature returned to 100°F. and his pulse remained between 100 to 110. He was definitely improved.

Specific pneumococci were not isolated from the sputum. Blood culture was negative and the leukocyte count had dropped to 14,650.

The remainder of his course was uneventful. He was allowed up twenty-one days after his jejunojejunostomy.

Except for his abdominal wound which was gradually healing and for some loss of weight he appeared to be in good condition. He was returned to the mainland for further convalescence and for a probable repair of his abdominal wall at a later date.

The second case, W. V. A., age twenty-eight, a gunner's mate third class, United States Navy, was admitted to the Medical service of the U. S. Naval Hospital, Pearl Harbor, T. H., on June 9, 1942. His diagnosis was compression injury (blast) of the abdomen and chest.

This man was about eighty yards away from his ship wearing a life jacket and hanging on to a life raft, with his back to the blast. Forty-five minutes after the blast he noted abdominal cramps which increased in severity.

On admittance, physical examination revealed a well developed and well nourished adult male who appeared critically ill. Temperature was 101.2°F., pulse 100, respirations 24. The abdomen was distended and tympanic. Rhonchi were noted over the base of the right lung on auscultation. Urinalysis revealed: albumin, one plus, 6 to 8 leukocytes and 5 to 10 erythrocytes per high dry field. Hemoglobin was 15 Gm. per 100 cc. of blood, erythrocytes 4,950,000 and leucocytes 12,400 in each cubic millimeter of blood. Total neutrophils in a differential smear were 76 per cent.

A roentgenogram of the chest revealed no definite pulmonary changes and the heart was not enlarged.

Roentgenoscopy of the abdomen showed no air under either diaphragm. However, the left diaphragm was relatively limited in motion and there was evidence of some pleural reaction in the left costophrenic angle. The right psoas muscle and right kidney were not visualized. Increased density was noted in the right side of the abdomen above the crest of the ilium. Numerous small bubbles of gas were noted behind the liver shadow and in the region of the right kidney. Some gaseous distention of the loops of the small intestine was noted but the findings were not characteristic of an obstruction.

Blood chemistry studies including non-protein nitrogen, chlorides and total protein were within normal limits.

The patient was placed under constant nasal suction. Glucose, saline and human plasma were administered. Sodium sulfadiazine was given intravenously and the following day the blood sulfadiazine level was 39.9 mg. per cent.

One week after admission the patient complained of pain high in the abdomen and some rigidity in the right upper quadrant was noted. The following day he developed a cough, rapid,

shallow respiration, and râles could be heard over both lower lung areas. A roentgenogram of the chest revealed areas of increased density in the lower lobes of both lungs.

Twelve days after admission, tenderness was present and a mass was palpable in the right upper abdominal quadrant. Leukocytes numbered 22,250 and a differential count revealed 2 juveniles, 35 bands and 42 segmented neutrophils, totaling 79 per cent.

After consultation with the surgical service (Dr. Pugh) the patient was transferred to the surgical department where the following day an exploratory laparotomy was performed through a right rectus incision, under local anesthesia. An abscess in the right anterior inferior hepatic space was drained. A large gangrenous slough, which appeared to be most of the greater omentum was removed along with a large amount of exudate and tissue detritus.

Following this he improved markedly. Copious drainage continued from the wound and three days after exploration fecal material was noted in the drainage.

About a week following the establishment of this fecal fistula a mass of tissue simulating the end of a gangrenous segment of gut presented in the wound. Upon slight traction it carried away and was delivered in its entirety. Examination revealed this to be a segment of large bowel measuring 8 cm. in length. The wound was cleansed and irrigated daily and small amounts of whole blood and plasma were given as supportive treatment.

On July 12, 1942, a barium enema was given. This revealed a fistula extending to the anterior abdominal wall from the superior portion of the hepatic flexure. The remainder of the colon showed no abnormalities.

On July 29th, the wound was almost completely healed. Free drainage had ceased and the patient was up and around.

He made an uneventful recovery and except for slight upper abdominal distress and nausea following meals had no complaints.

A gastrointestinal series on September 2, 1942, revealed some adhesions in the region of the second portion of the duodenum. No other abnormalities were noted in the gastrointestinal tract although the hepatic flexure was not subjected to further examination by means of a barium enema at this time.

Pathological examination of the removed

tissue revealed necrotic omentum and a segment of bowel showing evidence of old hemorrhage.

He was returned to a mainland hospital for further convalescence.

Aside from the interest which attaches to these cases by reason of their having sustained their original injury as a result of water blast, they are considered worthy of special report because of the unusual and interesting character of the pathological entities presented by each.

In the first case, that of R. L. S., several very notable and relatively rare features were presented:

1. This man sustained a perforation of his jejunum some two feet below the ligament of Treitz. The mortality rate from perforation of the jejunum from any cause is very high. More remarkable than his survival of this accident is the fact that this perforation sealed itself off spontaneously and never would have been discovered but for the subsequent developments which necessitated emergent operative intervention.

2. The patient developed a volvulus of his jejunum. This is rare. In the proceedings of the Staff Meetings of Mayo Clinic, Volume 17, No. 28, McKechnie and Priestly reported thirty-four cases in which thirty-seven operations were performed at the Mayo Clinic for volvulus of the small bowel. The jejunum *per se* was involved in only two of the thirty-four cases. In fact, volvulus of the entire small bowel is more common than volvulus of the jejunum alone.

The mortality from complete intestinal obstruction in the upper part of the alimentary canal is 100 per cent if not promptly relieved. When gangrenous bowel is involved in the obstruction whether from mesenteric thrombosis or strangulation, the prognosis becomes grave indeed.

In this case the proximal jejunum was gangrenous for a distance of 40 cm.

The mechanical factor which had made this volvulus possible was the adhesion of

the bowel, at the site of the jejunal perforation, to the parietal peritoneum opposite the upper pole of the left kidney.

Owing to the desperate condition of the patient at the time of the resection of the gangrenous bowel, attempt at restoration of the continuity of the intestinal tract was regarded as highly inadvisable. That there was a perceptible improvement in the patient's condition almost immediately upon clamping off the mesentery of this gangrenous bowel, is worthy of note.

A high intestinal fistula leads to rapid depletion and prostration of the patient. The importance of maintaining adequate fluid balance, food, electrolytes, digestive juices, caloric and vitamin intake, was recognized and successfully managed in this case.

With no more than one and one-half inches of the proximal jejunum projecting below Treitz ligament (and this in an unhealthy condition), the matter of accomplishing the re-establishment of the continuity of the bowel was mechanically tedious and difficult.

The Murphy button is an ingenious device introduced by the late John B. Murphy, a great and resourceful surgeon of one-half century ago. This button was used in establishing anastomosis in this case and we doubt that it could have been successfully effected by any other means aside from mobilizing the duodenum and bringing it over the transverse colon, after the method described by Lahey, which is in itself a formidable surgical undertaking.

That the Murphy button is indeed a potential life saver we think should not be lost sight of.

3. For this patient's ability in his weakened state to withstand and recover from

an intercurrent pneumonia some credit undoubtedly belongs to the effectiveness of the sulfonamide drugs (sulfathiazole) and much credit is due to the prompt and efficient management of the medical service of this hospital.

Lastly, in the final analysis, the importance of three valuable allies were reflected in the survival of this man: The stamina of youth, he was seventeen years of age; his indomitable courage; and his excellent physical condition at the time of his original accident.

The latter of these two cases was of unusual interest because it illustrates in particular two things. First, How so little in the way of surgery may mean so much. Here, an abscess was drained under local anesthesia and within a short time the patient's condition was converted from one of distress to one of calm and relative comfort; second, the assistance of nature when given a chance.

It seems remarkable enough that the continuity of the bowel may be re-established so satisfactorily by means of such a procedure as the Miekuliez operation. However, in this patient, after the entire greater omentum sloughed off, and the 8 cm. segment of the hepatic flexure or transverse colon had sloughed out, the bowel went on to re-establish its continuity and to resume normal function spontaneously.

Here, as with the pneumonia in the first case, the use of sulfadruugs may have prevented a lethal exodus from generalized peritonitis and again, as was pointed out in the first case, youth, stamina, and an attitude of the highest morale and vigorous health at the time of the original accident were on his side.



TYPHOID OSTEOMYELITIS*

CASE REPORT

GRAHAM A. KERNWEIN, M.D. AND RICHARD B. CAPPS, M.D.

CHICAGO, ILLINOIS

OSTEOMYELITIS was recognized as a sequel of typhoid fever as early as 1835 by Maisonneuve.¹ It was not until 1881, however, that Eberth² discovered the *Bacillus typhosum*, and 1888 that Ebermaier³ isolated the *Bacillus typhosum* in pure culture from two cases of osteomyelitis. The relation of the bone manifestations to the initial phase of the disease was thereby definitely established.

Clinical and experimental proof that the typhoid bacilli exist and linger longest in the bones gradually has accumulated. Chantemesse and Widal⁴ inoculated rabbits and recovered the bacilli only from the bone marrow. This localization in the bone marrow has been confirmed repeatedly in rabbits^{5,6} and guinea pigs.⁷ Quincke and Stühlen⁸ in nine postmortem examinations of individuals who had died of typhoid fever found the bacilli in the bones in each. Gerbasi,⁹ in thirteen cases of typhoid fever, obtained positive results from cultures taken from the tibial bone marrow. Since Gerbasi's report, approximately two hundred cases¹⁰⁻¹³ have been subjected to sternal puncture, all with positive results. Cultures of the stool, urine and blood in many failed to grow bacilli.

The bacilli remain viable for years after the initial attack, as attested by the cases cited in Table 1.

Improved sanitation and the inception of prophylactic measures to combat typhoid fever have decreased markedly the fre-



FIG. 1. Roentgenogram of forearm showing region of decreased density in ulna.

TABLE 1

Author	Time between Initial Attack and Recovery of Bacilli from Bone Marrow—in Years
Gore ¹⁴	11
Tubby and Hicks ¹⁵	13
Porter ¹⁶	20
Fogh ¹⁷	23
Garr ¹⁸	27

* From the Division of Surgery and the Department of Medicine, Northwestern University Medical School, Chicago, Illinois.

quency with which the disease is encountered. As the incidence of clinical osteomyelitis was 0.82 per cent in 18,840 cases of typhoid fever reviewed by Murphy,¹⁹ and as Winslow²⁰ in a review of all the medical literature up to 1923 found

only 101 bacteriologically proved cases of typhoid osteomyelitis, it is apparent that the disease is uncommon.

sulfamethylthiazole. A fourth patient responded neither to sulfamethylthiazole nor sulfanilamide. In vitro studies^{22,23} reveal

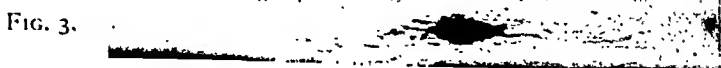
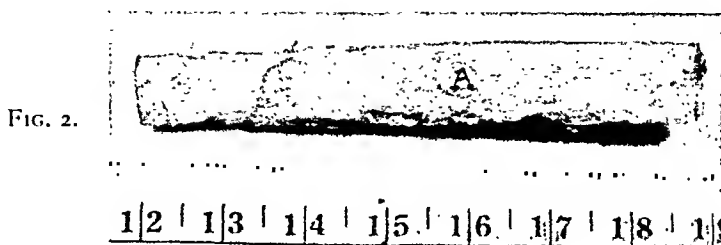


FIG. 2. Gross specimen. Cortical bone removed from ulna; periosteum greatly thickened in region A.

FIG. 3. Roentgenogram of specimen showing region of decreased density intact.

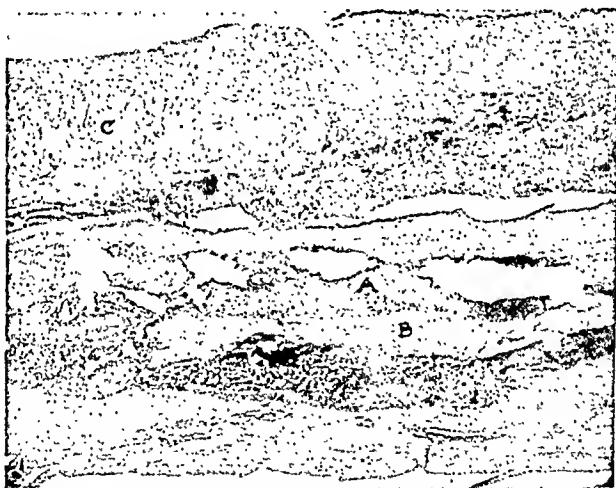


FIG. 4. Abscess cavity filled with necrotic detritus (A) and containing a sequestrum (B). Periosteal new bone (C) is present except in the region immediately overlying the abscess cavity. Here there is a mature type of granulation tissue containing clusters of closely packed mononuclear cells and foci of eosinophilic polymorphonuclear leucocytes. Most of the periosteal new bone has been destroyed leaving only a few remnants with irregular borders. $\times 24.5$.

In the treatment of typhoid fever and its sequels, the value of chemotherapy with the sulfonamide drugs has not been established. Weilbaecher, Moss, Taylor and Dupuy²¹ report good results in two cases and indefinite results in a third instance of typhoid fever treated with

that the sulfonamide drugs have a bacteriostatic action and that sulfathiazole is more active than sulfanilamide or sulfapyridine against the colon-typhoid-dysentery group. In this report apparent benefit resulted with chemotherapy locally in the bowel and at the operative site.

CASE REPORT

R. B., a white female, twenty-four years of age, contracted typhoid fever in March, 1941. An unfavorable course and prognosis were markedly improved following treatment with sulfaguanidine (70 Gm.) in divided doses beginning April 12, and continuing until April 22. The first negative stool was obtained May 20th and was followed by three others. Late in June, the patient noted a dull pain in her left forearm. The pain increased and by the second week was so severe as to interfere with her sleep. The pain was much worse at night.

Examination revealed a well nourished, cheerful, white female who did not appear acutely ill. The skin overlying the left ulna in a region 3 cm. in diameter, its center 10 cm. distal to the tip of the olecranon, was slightly reddened, edematous and boggy. The underlying bone was extremely tender to pressure. The remainder of the skeleton was negative.

The laboratory reported that the Wassermann was negative; red blood cells, 4,700,000; hemoglobin 14.5 Gm.; white blood cells, 15,300; differential count: lymphocytes, 23; polymorphonuclear neutrophils, 72; eosinophils, 3; monocytes, 2. In the urine there was no albumin, and no sugar; microscopically a few epithelial cells were found. Cultures for typhoid bacilli showed no growth on July 10, 1941. Stool cultures for typhoid bacilli showed no growth on July 10, 1941 and July 12, 1941.

The bone marrow removed at operation and cultured for typhoid bacilli was positive. The patient's temperature never rose above 99.2°F.

Roentgenological examination of the left forearm revealed an irregularly oval region of decreased density in the crest of the ulna. There was no endosteal reaction about the lesion but along the cortex, overlying the area of decreased density, the shadow of a minimal amount of periosteal new bone was seen. (Fig. 1.)

At operation the soft tissues were unusually adherent to the ulna in the proximal third. The periosteum beneath the edematous skin was markedly thickened and roughened. The periosteum was incised away from the thickened portion and a piece of cortex and attached periosteum were removed with the aid of an Albee bone saw. The lesion of osteomyelitis was not opened into; no pus was seen. Regional marrow was removed and sent to the

laboratory for bacteriological study. Cultures of this marrow grew only typhoid bacilli. The marrow cavity was packed with three



FIG. 5. Dead bone (A) surrounding the abscess cavity. The center of the cavity contains necrotic detritus (B). Peripherally there is a ground work of mature granulation tissue (C) containing many large mononuclear cells. The surfaces of the trabeculae are deeply serrated and in many of these pockets there are large cells (D) some with more than one nucleus. $\times 120$.

Gm. of sulfathiazole crystals and the soft tissues were closed tightly without drainage. The postoperative course was uneventful. The wound healed by primary intention.

Grossly the specimen consisted of dense cortical bone, 7.0 by 1.9 by 0.6 cm., and attached periosteum. The periosteum was markedly thickened, roughened and closely adherent. The medullary surface was slightly concave and smooth. (Fig. 2.) Roentgenological examination of the specimen revealed an area of decreased density in the center of the specimen. (Fig. 3.)

Microscopic sections were cut parallel with the long axis of the specimen. A layer of periosteal new bone was present, except immediately overlying the region of bone destruction. There the periosteal bone had been destroyed. Only isolated spicules remained in a ground work of dense fibrous

tissue. In some places, numerous large mononuclear cells were associated with regions of lacunar absorption where they lay close to the bony trabeculae. Elsewhere foci of eosinophilic polymorphonuclear leucocytes were present. In the central portion of the destructive lesion of the cortex the marrow spaces were filled with necrotic detritus and the bony trabeculae were devoid of bone cells. Peripheral to this in some places the marrow spaces were filled with a polymorphonuclear leucocyte type of granulation tissue. In others, the spaces were filled with a mature type of granulation tissue in which large mononuclear cells predominated. Where they lay opposed to the bony trabeculae, these cells were associated with regions of lacunar absorption. More peripherally, the enlarged Haversian canal systems were filled with an adult type of granulation tissue, a finding also present in pyogenic osteomyelitis and known as rarefying osteitis. (Figs. 4 and 5.)

Keen stated "the tendency to chronicity, to persistent sinuses and especially to recurrences are among the most marked characteristics of bone disorders following typhoid." This, coupled with the fact that an individual is a carrier so long as the bone lesion continues to drain typhoid bacilli, early resulted in a departure from the accepted methods of treatment of pyogenic osteomyelitis. While treatment of pyogenic osteomyelitis consisted of drainage and packing the wound open, the recommended treatment of typhoid osteomyelitis was to excise the lesion surgically and close the wound without drainage.²⁴ Although this method met with some success^{25,26,27} Murphy (1916),²⁸ following an exhaustive review of the subject, concluded that "the results of treatment of typhoid osteomyelitis are generally unsatisfactory."

In this report, the wound, created by surgical excision of the bone lesion, was packed with sulfathiazole crystals, then closed without drainage. The complete success of this method of treatment coupled with the excellent clinical response of the fever to sulfaguanidine, suggests that local chemotherapy with sulfonamide drugs is

beneficial in typhoid fever and typhoid osteomyelitis.

REFERENCES

1. MAISONNEUVE. These d'agregation, Paris, 1835.
2. EBERTH, CARL JOSEPH. Die Organismen in den Organen bei Typhus abdominalis. *Arch. f. path. Anat.*, 81: 58-114, 1880.
3. EBLERNAIER, A. Ueber Kochenerkrankungen bei Typhus. *Deutsche Arch. f. klin. Med.*, 44: 140-148, 1888-1889.
4. CHANTENESSE, A. and VIDAL, F. Recherches sur le bacilli typhique et l'etiology de la fièvre typhoïde. *Arch. de physiol. norm. et path.*, Par., 9: 217-300, 1887.
5. DMOCHOWSKI, Z. and JANOWSKI, Med. W. Ueber die Eiterung erregende Wirkung des Typhusbacillus. *Ziegler Beitr. z. path. Anat.*, 17: 221, 1891.
6. GAY, F. P. Typhoid Fever. New York, 1918. Macmillan Co.
7. LUDKE, H. Ueber den latenten Mikrobismus der Typhusbazillen. *München med. Wchnschr.*, 56: 57, 1909.
8. QUINCKE, H. and STÜHLEN, A. Zur Pathologie des Abdominaltyphus. *Berl. klin. Wchnschr.*, 15: 351-354, 1894.
9. GERBASI, M. Ricerche sulla patogenesi e sulla diagnosi della febbre tifoide nei bambini. *Pediatrics*, 32: 113, 1925.
10. DEBRÉ, R., LAMY, M., SÉL, G. and MALLARNE, J. L'exploration de la moelle osseuse (lamyelo-graphie et la medullo culture). *Presse méd.*, 44: 1853, 1936.
11. STORTI, E. and FILIPPI, C. Étude morphologique et bacteriologique de la moelle osseuse dans la fièvre typhoïde. *Sang.*, 11: 440, 1937.
12. BASSERGA, A. and BARBAGALLO, G. Die Sternalpunktion als bacteriologische Hilfsmethode. *Mcd. Klin.*, 34: 178, 1938.
13. SACKS, M. S. and HATCHER, F. W. A note on the bacteriologic culture of bone marrow in typhoid fever. *J. Lab. & Clin. Med.*, 26: 1024, 1941.
14. GORE, W. R. Case of caries of frontal bone and intracranial abscess due to bacillus typhosus eleven years after attack of typhoid fever. *Proc. Roy. Soc. Med., Surg. Sect.*, 1-4, 5: 1911-1912.
15. TUBBY, A. H. and HICKS, J. A. B. A case of suppurative posttyphoid osteitis 13 years after an attack of enteric fever. *Lancet*, 1: 304, 1913.
16. PORTER. Quoted by A. Wilensky. Osteomyelitis, its pathogenesis, symptomatology and treatment. P. 263. New York, 1934. Macmillan Co.
17. FOGH, R. Ein Fall von posttyphoser suppurativer Knochenentzündung mit ausserordentlich langwierigem Verlaufe. *Deutsche med. Wchnschr.*, 34: 1305, 1908.
18. GARR, C. C. Typhoid osteitis; report of two cases. *South. M. J.*, 20: 296-301, 1927.
19. MURPHY, J. B. Bone and joint disease in relation to typhoid fever. *Surg., Gynec. & Obst.*, 23: 119-143, 1916.

20. WINSLOW, N. Typhoidal osteomyelitis. *Ann. Surg.*, 77: 319, 1923.
21. WEILBAECHER, J. O., JR., MOSS, E. S., TAYLOR, H. M. and DUPUY, H. Treatment of typhoid fever by thiazole derivatives of sulfanilamide; preliminary report of four cases. *South. M. J.*, 33: 645-648, 1940.
22. LIBBY, R. L. and JOYNER, A. L. Action of sulfathiazole on colon-typhoid-dysenteriae group of organisms. *J. Infect. Dis.*, 67: 67-69, 1940.
23. RAMMELKAMP, C. H. and JEWELL, M. L. Comparative in vitro study of various sulfanilamide derivatives on typhoid-dysentery organisms. *Proc. Soc. Exper. Biol. & Med.*, 45: 169-174, 1940.
24. KEEN, W. W. Surgical complications and sequels of typhoid fever; based upon a review of 1700 cases. Philadelphia, 1898. W. B. Saunders.
25. UNGER, E. Beitrag zu den posttyphösen Knochen-eiterungen. *Deutsche med. Wchnschr.*, 27: 522, 1901.
26. DUPRAZ, A. L. Deux cas de suppurations (thyroidite et ostéomyélite) consécutives à la fièvre typhoïde et causées par le bacilli d'Eberth. *Arch. de méd. expér. et d'anat. path.*, 4: 76-84, 1892.
27. LILIENTHAL, H. Typhoid osteomyelitis. *Internat. J. Surg.*, 20: 71, 1907.
28. MURPHY, J. B. Bone and joint disease in relation to typhoid fever. *Surg., Gynec. & Obst.*, 23: 119-143, 1916.



GANGRENE is rarely encountered in the genital tract except in extreme degrees of puerperal infection, in malignant neoplasms, or as the result of torsion or thrombosis of the pedicle of benign neoplasms or of the broad ligament.

ACTINOMYCOSIS OF THE LIVER AND LUNGS

ROLAND T. SMITH, M.D.

DES MOINES, IOWA

THIS is a case of actinomycotic abscesses of the liver and lungs found at autopsy after a five and one-half month stormy convalescent period following surgical closure of a ruptured gastric ulcer.

After the closure of the ruptured ulcer, the patient left the hospital in five weeks against our advice. He returned in one month with pain and tenderness in the right upper quadrant which was controlled so well under ulcer management that he left the hospital in one week. He returned three weeks later with a stitch abscess. The abscess was drained and the patient seemed to make some improvement for one week, but from then on, he gradually lost ground and in three weeks signs and symptoms of a liver abscess developed.

After several transfusions and after general supportive measures were given in order to prepare the patient for an operation, a laparotomy was performed and the sinus tract was explored. The sinus tract extended from the old operative closure of the stomach to the anterior surface of the liver over the omentum, which had been sutured at the previous operation to the stomach at the site of the ulcer. It is interesting to note that the site of the operative closure of the stomach allowed no escape of gastric contents. The tract continued over the anterior and superior surface of the liver to the dome and from there it had burrowed along the thoracic wall, finally coming to the surface through the rectus muscle and skin just below the costal margin. No abscess could be found. The wound was closed with drainage, and the wound continued to drain thick, greenish-yellow exudate for seven weeks till the patient died. Smears from the pus, liver contents, and sputum, and the blood culture were negative for actinomycosis or any other pathogen. The

diagnosis of actinomycosis of the lungs and liver was made from the sections of the tissue obtained at autopsy.

There are two cases reported in the literature which are very similar to this case.^{2,7} In both cases there was x-ray evidence of thickened pleura in the bases. In both cases a liver abscess or subdiaphragmatic abscess was suspected and a laparotomy was performed at which time liver abscesses were found. The exudate of these abscesses did not contain the organism of actinomycosis. In one case there was a draining sinus from the lung, and smears from this material also were negative for actinomycosis as were the smears made from the sputum. In both cases at autopsy there were multiple abscesses in the lungs, and sections of this tissue showed actinomycosis.

Another case of actinomycosis of the liver followed a suppurative appendicitis. The appendix of this case contained the ray fungus.⁶ During the course of the illness, the anterior abdominal wall was later attacked and many fistulas developed.

In another case in which the lungs were primarily infected, there were later metastases to the pelvis. The most remarkable thing about this case was the spontaneous cure. Iodides, radium, and x-ray were not used.¹⁰

MORTALITY RATES

The mortality rate in actinomycosis of the liver is 80 to 100 per cent, and most writers fear the 100 per cent is more correct.¹⁻¹⁰ In actinomycosis of the lungs alone the mortality rate is a little less, being about 70 per cent.

SUMMARY ON TREATMENT

From the mortality figures it seems hopeless to discuss treatment, but occasionally

there are cures reported which appear to be due to the treatment. One such case of pulmonary actinomycosis was said to be

CASE REPORTS

This patient, J. A. No. 113040, a painter, was first seen at the hospital on June 2, 1941,



FIG. 1. This flat plate of the abdomen in the upright position was taken in the hour of the patient's admission to the hospital. It shows air under the diaphragm, a condition which in these circumstances is pathognomonic of a ruptured gastrointestinal tract.



FIG. 2. This x-ray was taken one month before the patient's death and shows a rather high diaphragm on the right side. There is some blunting of the right costal phrenic angle and slight infiltration of the right base. The film, however, is somewhat misleading in that, at autopsy, the left lung was involved as much as the right.

cured by three capsules of thymol daily, each containing 10 gr. (.65 Gm.) for seventeen days.³ Another author prefers to use radium, 6,900 milligram hours, in divided doses supplemented with potassium iodide and x-ray.³ The x-ray is probably best given with 135 peak kilovolts with 4 to 6 mm. of aluminum for filtration with two-thirds to three-fourths of an erythema dose.⁵ Saturated solution of potassium iodide is given in increasing doses till 600 minims (37 cc.) is given three times a day, or until tolerance is reached. Tincture of iodine may be given instead, 6 to 10 minims (37 to 61 cc.) in milk three times a day, or "collosol iodide," .2 of 1 per cent intravenously. Abscesses must be drained freely wherever they are found.

with symptoms of a ruptured peptic ulcer. There was a sudden severe pain in the epigastrium which caused the patient great anxiety. He was gasping for air and perspiring.

The past history is significant in that in 1911, the patient went to the Mayo Clinic for an examination which revealed that he did not have a peptic ulcer, although he had been having epigastric distress relieved by food or soda for one year. These symptoms continued until 1927 after which they did not return. He had had the usual childhood diseases. There was nothing of significance in the family history, cardiorespiratory, gastrointestinal or genitourinary systems.

Physical examination revealed the patient to be a well nourished, white male of fifty years, acutely ill. In the abdomen there was marked generalized tenderness and rigidity, somewhat more pronounced on the right side.

By rectal examination there was slight tenderness high in the pelvis. In the urine there were two to four white blood cells per high power



FIG. 3. The report from the pathologist on the tissue from which the above microphotograph was made was that the abscesses contained granules of the size and general morphology of the sulphur granules of actinomycosis. The margins of the granules are brush-like in appearance, but do not show deep clubbing, a fact which is consistent with tissue sections.

field and zero to one red blood cell per high field. In the blood there were 3,700,000 red blood cells and 6,000 white blood cells, 89 per cent polymorphonuclears and 11 per cent lymphocytes. An x-ray of the diaphragm in the upright position revealed large quantities of air beneath both domes.

An exploratory laparotomy was then done by Dr. D. W. Coughlin, at which time a perforation was found just above the pylorus. The perforation was closed with four interrupted catgut sutures and the omentum attached over this. A stab wound was made in the hypogastrium and a drain placed through this from the pelvis. Another drain was placed near the pylorus through the wound in the epigastrium, which was then closed in layers.

The patient had the expected, somewhat stormy, post-operative course with the temperature reaching 101°F. occasionally, and on

one day, 103°F. The wound became infected and drained a considerable amount of purulo-sanguineous exudate and was still draining some when the patient left the hospital on the thirty-eighth postoperative day against our advice. He was given a ten-day Sippy diet, amphojel, cevitic acid, Brewer's yeast, and told to stay in bed.

The patient returned in exactly one month complaining of a constant pain in the epigastrium which radiated to the right side and was accompanied with considerable eructation. The only significant findings on examination were the healed right rectus scar, tenderness and spasm in the epigastrium, severe pain on deep pressure, and the lack of palpable organs and masses. The laboratory at that time showed 3,700,000 red blood cells and 13,200 white blood cells, 74 per cent polymorphonuclears and 16 per cent lymphocytes. The urine had very occasional white blood cells. Fluoroscopic examination of the chest was negative. Oral barium demonstrated a normal esophagus, stomach filled well and was smooth and pliable. The duodenal bulb was poorly visualized and appeared irregular throughout the examination. Both sections of the diaphragm moved satisfactorily. Films showed the irregularity of the bulb. The patient's distress soon ceased on bed rest and ulcer management, and he was discharged in one week on the same treatment.

Three weeks later the patient returned complaining of pain and swelling at the upper part of his old abdominal incision. The significant finding on examination was a large subcutaneous abscess under the upper part of the wound which was promptly incised and drained, whereupon, three ounces of thick, green pus was obtained. The laboratory report at that time was 3,700,000 red blood cells, 70 per cent hemoglobin, 15,000 white blood cells with 77 per cent polymorphonuclears and 23 per cent lymphocytes. A smear from the pus showed few pus cells but no bacteria. On the nutrient broth culture there was no growth.

There was a profuse greenish-yellow discharge from the wound for five days after which the discharge greatly diminished but never ceased. After the drainage from the wound became less profuse, the temperature began to rise slowly each day with a spike of fever in the late afternoons. After one week of this a chest x-ray revealed slight elevation of the right diaphragm with no evidence of

accumulation of free air or gas below the diaphragm.

The temperature curve continued to spike each afternoon to 102°F. and after four days a fluoroscopic examination showed the right diaphragm not elevated but definitely limited in movement and the right liver shadow much larger than normal. There was no evidence of free air or fluid level under either diaphragm.

The wound was probed and a sinus was found leading up under the costal margin for three inches. A subdiaphragmatic abscess was suspected so the patient was given transfusions and general supportive measures in preparation for an exploratory operation later. In two weeks a chest x-ray showed blunting of the right costal phrenic angle and slight haziness in the right base.

An exploratory laparotomy by Dr. R. A. Burnside was then done through the right upper quadrant exposing the liver and stomach. A sinus tract composed of chronic granulation tissue was found extending from the anterior abdominal wound to the dome of the diaphragm. From there the tract ran over the superior and anterior surface of the liver and then over omental adhesions to the site of the old operative closure of the stomach which appeared to be well sealed and would allow no escape of gastric contents. No abscess or any gross pus was found. The liver appeared normal. One large rubber drain, and a long thin strip of gauze was placed over the liver, and the abdomen was closed in layers. For a number of days the wound continued to drain a profuse amount of greenish-yellow exudate and later it became only moderate in amount.

The patient gradually failed, spiking a temperature of 103 to 104°F. every day. Three weeks postoperatively, a chest x-ray revealed a high diaphragm on the right side and a slight infiltration of the right base. Three weeks later an attempt was made to aspirate an abscess in the liver but this was unsuccessful. A blood culture was negative, the sedimentation rate was 100 mm. per hour; the Wassermann was negative; agglutination for typhoid and undulant fever was negative. The sputum was negative for any bacteria. The prothrombin time was 44 seconds (the control was 35 seconds). The icteric index was 6 (normal, 4 to 8). The Van den Bergh was direct, but delayed one minute. The white blood cell count during the last month of his illness ranged

from 12,000 to 23,000, slipping to 7,400 the last week. The red blood cell count continued to drop slowly to 2,400,000 in spite of multiple transfusions. He died fifty-one days after the exploratory operation.

At autopsy, these were the significant findings: In the skin of the abdomen there was a denuded area about 8 cm. in diameter from a suppurating fistula just below the costal margin on the right side. The peritoneal cavity contained 300 cc. of straw-colored fluid, and between the right diaphragm and the dome of the liver, there were numerous adhesions. The pleural cavities each contained 200 cc. of straw-colored fluid. The heart was smaller than average. The coronaries were quite atherosclerotic. Both lungs contained numerous small abscesses measuring 1 to 3 cm. in diameter, containing green pus. The specimen was enlarged and quite firm. In the gastrointestinal tract there was a perforating, but not perforated, gastric ulcer with adhesions into the right lobe of the liver. The liver was filled with multiple abscesses varying from 2 to 5 to 6 cm. in diameter, containing a thick greenish, foul, purulent material. These abscesses appeared more or less in clusters in the liver and seemed to be loculations of one continuous system. This arrangement was not so definite in the lungs. A few areas of the liver were very soft and necrotic.

SUMMARY

1. A case of actinomycotic abscesses of the lungs and liver is presented.
2. When the patient entered the hospital he had signs and symptoms of a ruptured peptic ulcer. The ruptured ulcer was found at surgery and closed successfully.
3. Signs and symptoms of a liver abscess developed two months after the surgical closure.
4. A chronic sinus tract was found at an exploratory laparotomy. This sinus tract extended from the anterior abdominal wall to the dome of the liver and from there to the old operative closure of the stomach, which, however, allowed no escape of gastric contents.
5. The wound drained a thick, greenish-yellow exudate for seven weeks till the patient died.

6. Smears of the pus, liver contents and sputum, and a blood culture were negative for actinomycosis or any other pathogen.

7. The diagnosis of actinomycosis of the lungs and liver was made from the sections of the tissue obtained at autopsy.

8. Treatment is unsatisfactory. Iodides, thymol, x-ray, and radium have been used.

REFERENCES

1. ARIBAUD, G. Hepatic localizations of actinomycosis. *Internat. Clin.*, 3: 50, 1931.
2. COTTLE, G. F. and SATTERLEE, R. C. Actinomycosis of liver and lungs. *U. S. Nav. M. Bull.*, 19: 341-343, 1923.
3. ETTER, L. E. and SCHUMACHER, F. L. Pulmonary actinomycosis: recovery after thymol therapy. *J. A. M. A.*, 113: 1023-1024, 1939.
4. GOOD, LOUIS P. Actinomycosis of the thorax. *Arch. Surg.*, 21: 786-800, 1930.
5. GOOD, LOUIS P. Thoracic actinomycosis, with report of case of primary type. *Texas State J. Med.*, 30: 245-250, 1934.
6. GREENWELL, A. W. Actinomycosis of liver following suppurative appendicitis. *Mil. Surgeon*, 62: 185-197, 1928.
7. HUTCHINSON, R. W. and ZUNDELL, J. L. Actinomycosis of lungs and liver; report of case. *U. S. Nav. M. Bull.*, 38: 325-329, 1940.
8. LEMON, W. S. Pulmonary actinomycosis. *Minnesota Med.*, 9: 211-213, 1926.
9. SCHNEIDER, L. V. and FINUCANE, D. L. Pulmonary actinomycosis complicated by pneumothorax treatment. *Dis. of Chest*, 7: 229-235, 1941.
10. TREVITHICK, E. A case of actinomycosis: primary abscess of left lung exhibiting spontaneous cure; metastatic manifestation in the pelvis declaring itself after a years' latency with abscess formation and slow spontaneous cure. *Lancet*, 2: 158, 1906.



FIBRO-ADENOMATA of the cervix differ from those arising in the endometrium only in the fact that they are rough on the surface, are covered with the cervical type of mucosa, and do not usually exhibit the changes of the menstrual cycle.

MECKEL'S DIVERTICULUM AS A CAUSE OF INTESTINAL OBSTRUCTION*

REPORT OF A CASE OF VOLVULUS

MILTON ROTHMAN, M.D.
Resident Surgeon, Harlem Hospital;
Pathologist, Harlem Hospital

AND

DOMINICK F. ZETENA, M.D.
Associate Surgeon, Harlem Hospital; Assistant
Surgeon, St. Vincent's Hospital

NEW YORK, NEW YORK

INTESTINAL obstruction not infrequently follows Meckel's diverticulum. Such a case recently occurred at Harlem Hospital. The formation of Meckel's diverticulum as a remnant of the omphalovitelline duct through which nourishment passes from the yolk stalk to the embryo has been amply discussed and reiteration is unnecessary.

In 1809, Johann Friedrich Meckel¹ described the condition which bears his name. The early reports were for the most part concerned with intestinal obstruction. Meckel observed that this congenital anomaly in the omphalovitelline vessels could easily act as a band producing an obstruction. This probably was the mechanism in the first case of intestinal obstruction due to this cause, that of Van Doeveren, which was described by Sandifort² in 1793.

The incidence of Meckel's diverticulum has been variously estimated from 0.14 to 3 per cent. The condition occurs more commonly in males than in females. The diverticulum usually occurs from 3 to 100 cm. above the ileocecal valve. The site apparently depends upon the amount of growth in that portion of the intestine proximal to the insertion of the omphalovitelline duct. Therefore, in infants in whom complete growth has not yet taken place it may be found closer to the ileocecal valve than in adults. It may be a thin fibrous band, cystic or bulbous, with a narrow or broad base. Diverticuli arise opposite the mesentery of the bowel, but may be lateral or even intramesenteric.

Histologically, it must be classified as a true diverticulum for its walls are identical with that of the intestine. It is estimated that heterotopic tissue such as gastric and duodenal mucosa, or pancreatic tissue, is present in 15 per cent of the cases.

The vast majority of diverticula lie free in the peritoneal cavity and usually give no symptoms. Although a blind pouch, it seldom entraps foreign bodies. Nearly always, the symptoms arise from one of the various complications to which the diverticulum is subject. Halstead³ states that 6 per cent of 991 cases of intestinal obstruction were due to Meckel's diverticulum. Although these figures are undoubtedly high, nevertheless one notes that Meckel's diverticulum is not an uncommon cause of intestinal obstruction. Harkin's⁴ report shows that Meckel's diverticulum is a factor in about 2 per cent of all cases of intussusception. Miller and Wallace⁵ found sixty-three cases of intussusception in 201 cases of Meckel's diverticulum. In this group there were twenty-six other cases of intestinal obstruction.

Meckel's diverticulum may produce intestinal obstruction in one of the following ways: (1) Meckel's diverticulum may form the contents of a hernial sac, (2) intrinsic mechanism causing intussusception, and (3) extrinsic mechanism (a) free diverticulum, (b) adherent diverticulum.

HERNIAL SAC

The diverticulum may form partial or complete contents of a hernial sac. Mathew⁶ presented a case in which a

* From the Surgical Service of Dr. Leon Ginzburg, Harlem Hospital, New York City.

diverticulum was found in a femoral hernia. In another case the diverticulum was brought down into an inguinal hernia by the descent of the testis. Biodorax⁷ noted a sciatic hernia which contained an adherent diverticulum. Other authors noted similar findings in umbilical hernias. On the whole, these are uncommon. Wellington,⁸ in 1913, collected seven such cases in 1,326 cases of Meckel's diverticulum.

INTRINSIC MECHANISM—INTUSSUSCEPTION

Almost always the diverticulum is situated at the apex of the intussusceptum. Probably the starting point is the expulsion of a fecal mass or a concretion from its lumen into the intestines. The diverticulum becomes inverted and acts as a polyp to initiate an intussusception. The conditions essential in the invagination of the diverticulum are two-fold, a free tip and a broad base. The chief subject of argument has been whether the diverticulum invaginates primarily or secondarily. At present, the bulk of the evidence favors the view that the inversion is primary. In Harkin's series of cases, intussusception occurred mostly in the group above two years of age. It is the opinion of Mathews that Meckel's diverticulum is not a cause of intussusception in young children.

EXTRINSIC MECHANISM

(A) *Free Diverticulum.* There are several ways in which a free diverticulum may produce an obstruction. A knot may be tied around a loop of gut. This requires a good size diverticulum of unusual length and great range of mobility. Dragging and kinking of a loop of intestine may be produced by a distended diverticulum. It is obvious that acute flexion occurs more frequently when the distal end of the diverticulum is attached. Similarly, twisting of the bowel on its long axis at the point of origin of the diverticulum is more frequently found in the adherent diverticulum. Chronic inflammation of a diverticulum may involve the base resulting in a cicatricial narrowing of the gut at the origin of the diverticulum. In

the operative treatment of a diverticulum, one may cause an obstruction by inversion with purse-string suture.

(B) *Adherent Diverticulum.* A tip of a diverticulum may attach itself to adjacent viscera or the abdominal wall, and cause a partial or complete intestinal obstruction. This is the result of an inflammatory process. On the other hand, the diverticulum may have remained attached to the umbilicus embryologically, and the obstruction may be secondary to this mode of adherence. These bands may constrict the bowel or the circulation of a loop of gut that has tunneled its way underneath the band. As mentioned above, dragging, of the bowel, or twisting of the diverticulum would be more common in this group. McKenzie⁹ and Symmonds¹⁰ each reported cases in which a loop of gut passed underneath an adherent diverticulum and became twisted on itself, producing a volvulus. Lower¹¹ presented a report of a volvulus of a loop of ileum around an acutely inflamed diverticulum which was adherent to the cecum. The volvulus was relieved and the diverticulum removed. A case is now presented in which a Meckel's diverticulum became adherent to a loop of ileum, and the whole mass was twisted 720 degrees upon itself, producing a volvulus.

CASE REPORT

G. K., a colored male, aged twenty-nine years, was admitted to Harlem Hospital on August 19, 1941, with the history of having had a sudden attack of crampy umbilical pain two days previously. Vomiting of thin greenish fluid accompanied the pain. The symptoms became progressively worse. There was no passage of flatus for ten hours. The history did not reveal melena, distention, previous operations, enema or a previous similar attack.

Physical examination revealed an acutely ill colored man complaining of constant pain in the lower abdominal quadrants. Skin turgor was poor and he appeared dehydrated. The upper part of the abdomen was moderately distended. The lower quadrants were rigid and presented rebound tenderness. There were no masses. On rectal examination a tender mass was felt in the cul de sac.

The temperature was 101°F., the respiration was 20 and the pulse was 110 beats per minute. The hemogram showed the following: erythrocytes 3,200,000, hemoglobin 70 per cent, leukocytes 16,900. The differential count showed polymorphonuclear leukocytes 69 per cent, transitional cells 12 per cent, monocytes 3 per cent and lymphocytes 16 per cent. The urine was negative for sugar and albumin. The specific gravity was 1.018 and there was two plus acetone.

An operation was performed three hours after admission. Under 12 mg. pontocaine spinal anesthesia, a right rectus splitting incision was made. The peritoneal cavity contained about 2,500 cc. of sanguineous, fecal smelling fluid. A round purplish mass measuring 10 by 10 by 12.5 cm. was found bound down in the right pelvis. It was necessary to untwist the mass 720 degrees counterclockwise before it could be delivered. At this point, a distended Meckel's diverticulum was noted to be adherent to a loop of ileum. This point of adherence was evidently the pivotal point for the volvulus. The entire loop of ileum, measuring about 4 feet (120 cm.) starting 6 inches (15 cm.) from the ileocaecal valve, was gangrenous and the mesentery was thrombosed. A resection of the gangrenous bowel was performed. Because of the proximity to the cecum, after the resection was completed, an ileotransverse colostomy in a side-to-side manner was performed. Twelve Gm. of sulfanilamide was placed into the abdominal cavity. The abdomen was closed in layers without drainage.

The surgical pathologic report follows: The specimen consisted of 4 feet of small intestine. The entire specimen was completely gangrenous except for 6 inches at either end. Eight inches from the distal end, was a blind finger-like projection measuring 3 by 2 by 1.0 inches. The tip was bulbous and a denuded area was noted at the tip where it had been adherent to a loop of ileum. No areas of perforation were present. The mesentery was hemorrhagic and thrombotic for a distance of 3 inches from the bowel wall. The bowel and diverticulum were filled with thick sanguineous fluid. No fecoliths or purulent material were present in the diverticulum.

Following the operation the temperature ranged between 101° and 102°F. for the first three days. On the fifth day, the temperature was normal, daily bowel movements were started on the fourth day. Sutures were re-

moved on the seventh day and the patient was out of bed on the sixteenth day and went home on the nineteenth day. Immediate postoperative therapy consisted of infusion of normal saline and 5 per cent glucose, two transfusions of 500 cc. citrated whole blood, duodenal tube and Wangenstein drainage. Sodium sulfathiazole 4 Gm. was given intravenously upon return to the ward and then 1 Gm. every four hours for five days thereafter. The patient received 500 mg. of vitamin C and 100 mg. of vitamin B₁ daily throughout his stay in the hospital.

The symptoms are those of any intestinal obstruction: vomiting, colicky pain, obstipation or constipation, and distention. It is apparent that a diagnosis of intestinal obstruction can be made, but a definite diagnosis of obstruction secondary to a Meckel's diverticulum can only be made with exceeding difficulty. However, such a condition can be suspected. In those cases in which the cause of the obstruction is not apparent, the possibility of the presence of a Meckel's diverticulum should be suspected. A previous history of melena may be helpful. In cases in which the intussusception is made in older children and adults, a diverticulum should be thought of as a possible cause. Roentgenograms show obstruction during the acute stage.

The treatment of the hernial sac and bands due to Meckel's diverticulum is essentially the same. The obstruction should be relieved and the diverticulum removed. However, one must be aware of the possibility that a stricture might be caused by inverting with a purse-string suture. After removal of the diverticulum the intestine should be closed transverse to the long axis of the bowel. The handling of a diverticulum resulting in an intussusception depends on the operative findings. It may be relieved simply by disinvagination. If the invagination cannot be relieved, a resection must be performed in a one or two-stage procedure.

SUMMARY

The subject of intestinal obstruction following Meckel's diverticulum is generally

discussed. The details of a case of volvulus secondary to Meckel's diverticulum with operation and recovery are also presented.

REFERENCES

1. MECKEL, J. F. Ueber die Divertikel am Darmkanal. *Arch. f. d. Physiol.*, 9: 421-453, 1809.
2. SANDIFORT. *Museum Anatomicum*. Series 111, 1: 121, 1793.
3. HALSTEAD, A. E. Intestinal obstruction from Meckel's diverticulum. *Ann. Surg.*, 35: 471-494, 1902.
4. HARKINS, H. N. Intussusception due to invaginated Meckel's diverticulum. *Ann. Surg.*, 98: 1070-1095, 1933.
5. MILLER, R. H. and WALLACE, R. H. Meckel's diverticulum in acute abdominal emergencies. *Ann. Surg.*, 98: 713, 1933.
6. MATHEW, F. Meckel's diverticulum. A report of 12 cases. *Arch. Surg.*, 10: 720-729, 1925.
7. BIODORAX, JOHN W. Sciatic hernia: report of a case of hernia of Meckel's diverticulum through the greater sciatic foramen. *J. A. M. A.*, 82: 440-442, 1924.
8. WELLINGTON, J. R. Meckel's diverticulum with report of four cases. *Surg., Gynec. & Obst.*, 16: 74-78, 1913.
9. MCKENZIE. (Quoted by Halstead.) Transactions of the London Pathological Society 1889-1890.
10. SYMONDS. *Brit. M. J.*, December 4, 1897. (Quoted by Halstead.)
11. LOWER, W. E. Intussusception in adults due to the invagination of a Meckel's diverticulum. *Ann. Surg.*, 82: 436, 1925.



GLANDULAR cancer of the vulva may arise from any of the glandular structures of the skin or mucosa, or from definite glands such as the vulvo-vaginal gland.

The brief excerpts in this issue have been taken from "Essentials of Gynecology" by Willard R. Cooke (J. B. Lippincott Company).

GLIOBLASTOMA MULTIFORME

REPORT OF THREE CASES

HENRY WARD WILLIAMS, M.D.
Senior Neurosurgeon, Highland Hospital

AND

WILLIAM P. E. BERWALD, M.D.
Junior Neurosurgeon, Highland Hospital

ROCHESTER, NEW YORK

GLIOMAS constitute almost 50 per cent of all intracranial neoplasms, and of these, the glioblastoma or spongioblastoma multiforme is the commonest. This tumor is the most malignant of all cerebral neoplasms with the possible exception of the medulloblastoma. The average duration of life from the time of discovery is approximately seven months. They tend to occur in middle-aged and elderly people and are characterized by a rapid progression of those signs and symptoms associated with an intracranial space-occupying lesion. Many of these tumors are unfortunately situated either subcortically, or in areas where their removal would be followed by a hemiplegia, aphasia, or visual-field defect. On the other hand, some will be situated in relatively "silent" areas of the brain, such as the right frontal or postfrontal regions in right-handed individuals, and it is these that are most amenable to surgical attack.

In the past two and one-half years we have effected apparently complete extirpation of three grade IV spongioblastoma multiforme tumors in three male patients, all in the fifth decade of life. One patient has now lived two and one-half years following surgery, another one year, and the third patient eight months. All three are in good general health at the present time, and two of the three have been economically rehabilitated. We present below case reports on these patients, all of whom are right-handed, and had right postfrontal gliomas:

CASE REPORTS

CASE I. D. R., a male, age forty-six, was admitted to St. Mary's Hospital January 5, 1940, with the diagnosis of "Jacksonian

epilepsy." One year before admission he was seized by a "fit" involving the left face, arm and leg, not accompanied by unconsciousness. Similar episodes had occurred subsequently at irregular intervals. Some spells were preceded by olfactory hallucinations. There had been some blurring of vision and rather steady occipital headache.

Examination of the central nervous system was objectively negative. The optic disc margins appeared distinct. Our impression was right temporal lobe tumor. An encephalogram was performed. The spinal fluid initial pressure was 420 mm. water; 142 cc. of cerebrospinal fluid were recovered. Radiographs showed a convexity of the outer border of the right lateral ventricle.

Craniotomy was performed under avertin, gas oxygen and novocaine. A right temporo-parietal five-hole osteoplastic flap was made. The dura was tense and on reflection a gelatinous mass, one and three-quarters inches in diameter, in the temporal lobe and bordering the Sylvian fissure, came into view. The mass was removed with the cutting loop and a subtemporal decompression was performed. Rapid frozen section of biopsy diagnosed malignant glioma. The operative time was three hours and twenty-five minutes. The patient received 350 cc. citrated blood immediately following operation.

Postoperatively there was no aphasia or weakness. The fourth postoperative day the patient had a convulsion limited to the left side. The patient was discharged on the thirteenth postoperative day improved.

Permanent section of the biopsy was diagnosed a very cellular malignant glioma.

Since operation, he has had from three to five Jacksonian seizures per month. The spells are limited to the left side, are of short duration and are not accompanied by unconsciousness. It is now two and one-half years since his operation. His general health is good, his decompression is soft and pulsates, and his optic disc

margins are distinct. He has not, however, become economically rehabilitated.

CASE II. M. McD., a male, age forty-eight, was admitted to Highland Hospital July 10, 1941, with the diagnosis of "convulsions." Eight years before admission he had a Jacksonian convulsion lasting an hour, and involving only the left arm. Another similar spell occurred six years later and was followed by weakness in the left arm which persisted. He had repetitive Jacksonian convulsions for six hours prior to admission. Severe headaches had been present for several months.

Examination of the central nervous system revealed mental lethargy. The external ocular movements were defective in upward and right lateral gaze. The tongue deviated to the left. Strength in the left arm was minus two, in the left leg and foot, minus one. The deep reflexes in the left arm were plus two. Babinski's sign was positive bilaterally. Ankle clonus was plus two on the left. The optic disc margins were distinct. Our impression was right postfrontal tumor. An encephalogram was performed. The spinal fluid initial pressure was 650 mm. water; 100 cc. of cerebrospinal fluid were recovered. The radiographs were unsatisfactory.

Craniotomy was performed under avertin, ether vapor and novocaine. A right frontotemporal five-hole osteoplastic flap was made. The dura was tense, and on being reflected disclosed a yellowish, gelatinous mass over the anterior aspect of the decompression. A tumor the size of a horse chestnut was removed with the cutting loop, and a subtemporal decompression was done. The dura was left open. Rapid frozen section of the biopsy diagnosed glioma. The patient received 500 cc. of citrated blood during the operation. The operative time was three hours and five minutes.

Postoperatively the patient presented a left hemiplegia; however, he moved his left leg the third postoperative day and his left arm the fifth postoperative day. He developed a *Staphylococcus aureus* wound infection which was treated successfully by irrigation of 1-5000 neutral acriflavine and the oral administration of sulfathiazole. He was discharged on the twentieth postoperative day, improved.

Permanent section of the biopsy was diagnosed spongioblastoma multiforme.

The patient was referred to a radiologist for post-operative x-ray treatment. It is now one year since his operation. His general health is

good, he has had no headaches or Jacksonian seizures. The strength in both arms and hands is equal. His decompression is soft and pulsating and his optic disc margins are distinct. He has become economically rehabilitated.

CASE III. H. G., a male, age forty-three, was admitted to Highland Hospital November 1, 1941, with the diagnosis of "hypertension." One month prior to admission, the patient complained of involuntary blinking of the eyelids, headaches and fatigue. His wife noticed that he was difficult to arouse in the morning and was very slow in getting dressed. For a week or so prior to admission, the patient had failed to keep important appointments.

Examination of the central nervous system revealed slight drooping of the left corner of the mouth. There was blinking and nystagmoid movements of the eyes. There was questionable weakness of the left arm and hand. The left patellar reflex was plus two. The left upper abdominal reflex was minus four. The left middle and lower abdominal reflexes were minus two. There was slight blurring of the nasal margin of the right optic disc. The patient presented some dysarthria and Witzelsucht. Our impression was right postfrontal tumor. An encephalogram was performed. The spinal fluid initial pressure was 600 mm. water; 121 cc. of cerebrospinal fluid were recovered. The radiographs revealed displacement of the ventricular system to the left with flattening of the upper surface of the right lateral ventricle and dilatation of the left lateral ventricle.

Craniotomy was performed under local anesthesia only. A right frontotemporal five-hole osteoplastic flap was made. The dura was very tense and did not pulsate. A large subtemporal decompression was done after which the dura was then reflected revealing a large gelatinous tumor two inches in diameter and well demarcated from the surrounding normal gray matter. The flap had to be enlarged anteriorly to obtain full exposure. The tumor and 1 cm. of surrounding brain tissue was removed with the cutting loop almost down to the wall of the ventricle. A large old blood clot was present within the tumor mass. A drain was left in the tumor cavity and the dura closed around it. Rapid frozen section of the biopsy diagnosed glioma. The patient received 500 cc. of citrated blood during the operation. The operating time was four hours and fifteen minutes. As the patient was being transferred

from the operating table to the stretcher at the conclusion of the operation, he said, "This has been better than a Marx Brothers' comedy." The evening of the operation, he talked well and moved all extremities well. He was discharged on the eleventh postoperative day, improved. Permanent section of the biopsy was diagnosed spongioblastoma multiforme. He was referred postoperatively to a radiologist for x-ray therapy. Two and one-half months following operation, he had two generalized convulsive seizures. None has occurred since. It is now eight months since his operation. He has had no headaches, feels well, his decompression is fairly soft and pulsates, and his optic disc margins are distinct. He has become economically rehabilitated.

REMARKS

It is impossible to state with accuracy from a neurosurgeon's viewpoint, that any glioma has been completely removed. The pathologist's report at postmortem has convinced us of this. Therefore, we refer all postoperative glioma cases to a radiologist for courses of deep x-ray therapy, and we are convinced that the continued well being of the above cases is due in no small measure to the influence of the x-rays in

retarding or preventing further growth of whatever remains of the tumor cells.

Inasmuch as glioblastoma multiforme tumors possess no capsule, either of connective tissue or of glial tissue, it is imperative that in attempting complete extirpation surgically, the cerebral tissue excised should extend for at least a centimeter or better at all points beyond the visible margin of the growth. After removal, a thorough "cooking" of the walls of the remaining crater should be carried out with the electric cautery.

We believe that in every case of glioma a large subtemporal decompression should be done, irrespective of whether or not the tumor be removable. We realize that this procedure may hasten the growth of the irremovable tumors, but the beneficial effect that decompression has on the headaches and general well being of the patients out-weighs this disadvantage.

In the case of subcortical growths which unfortunately greatly preponderate, a lobectomy may be attempted but the relatives' attitude toward the end result must be weighed carefully against the surgeon's heroism.



SUCCESSIVE, COEXISTENT TUBAL PREGNANCIES*

CASE REPORT

R. M. MITCHELL, M.D.

Resident Physician, Obstetrics and Gynecology,
Greenpoint Hospital

AND

LAWRENCE KURZROK, M.D.

Associate Attending Gynecologist,
Greenpoint Hospital

BROOKLYN, NEW YORK

SINCE H. R. Fishback¹ reviewed the literature (1939) there have appeared four additional case reports of bilateral tubal pregnancy to add to the growing list, bringing the total of accepted cases to eighty. The latest case was reported by Cox and Steinberg.² To this number we wish to add an additional instance of "successive, coexistent tubal pregnancy."

The preoperative diagnosis was (a) chronic pelvic inflammatory disease, (b) fibroid tumor of the uterus, and (c) ectopic pregnancy was considered but the diagnosis was not definitely established prior to surgery. A left tubal pregnancy undergoing tubal abortion was found at operation and upon further inspection it was determined that the supposed fibroid of the uterus was another ectopic pregnancy involving the interstitial portion of the right tube.

CASE REPORT

The patient, a thirty-one year old white female, entered Greenpoint Hospital July 15, 1942. She was gravida vi, para iii, all normal deliveries; her youngest child was three years old. Two criminally induced abortions in June, 1940, and February, 1941, had been performed; the postoperative course was uneventful in each case. Onset of menstruation was at thirteen years; it occurred every six weeks and lasted for six days; the flow was heavy the first three days and there was no dysmenorrhea. The last normal menstrual period occurred April 30, 1942. The previous periods were normal. The past history was irrelevant.

The patient first sought medical advice during the first week of July, 1942, because of prolongation of her period and the onset of left lower quadrant pain—"cramps." The menstrual abnormality started on May 15, 1942, at

which time she flowed for six days (two weeks after last normal period). The bleeding ceased and started again on June 26, 1942; the flow was moderate in amount and continued until the date of admission.

Physical examination revealed a well developed, well nourished white female not acutely ill; pulse 78, temperature 98.6°F., respirations 16 per minute and blood pressure 110/64.

General examination was negative. The abdomen was flat, no masses were palpable; tenderness was present in the left lower quadrant. No inguinal adenopathy was noted. Vaginal examination was done. The external genitals were normal, introitus parous and pelvic support good. There was no evidence of infection in Bartholin's glands or Skene's ducts. The cervix pointed posteriorly and was lacerated slightly. The corpus uteri was retroverted but freely mobile and could be replaced; the uterus was enlarged to the size of a six weeks' gestation and was firm in consistency; a firm irregularity in the right midportion of the fundus uteri about 3 cm. by 3 cm. in diameter was felt. This appeared to be a solitary fibroid. A left adnexal mass was palpable, cystic in consistency and twice the size of a normal ovary. The right adnexa was palpable and essentially normal. Laboratory findings were as follows: red blood cells, 4,480,000; white blood cells, 8,300, hemoglobin, 82 per cent; sedimentation time, one hour plus; urine, negative; and the Wassermann and Kline tests were negative.

A low midline incision was made through the abdominal wall. On opening the peritoneal cavity free blood was visible, the amount present was about 500 cc. The left tube was found enlarged in the region of the ampulla, congested, tense, shiny and spindle-shaped. The ostium of the tube was patent and evidence of recent hemorrhage through that opening

* Title used by Behney and Hanes in their case report.

present; clots were removed from the tube. There was no evidence of external rupture of the tube at any point. A recent corpus luteum

small amount of red-brown friable material. The wall of the cavity is mottled yellow and gray-white. The surrounding tissue is firm,

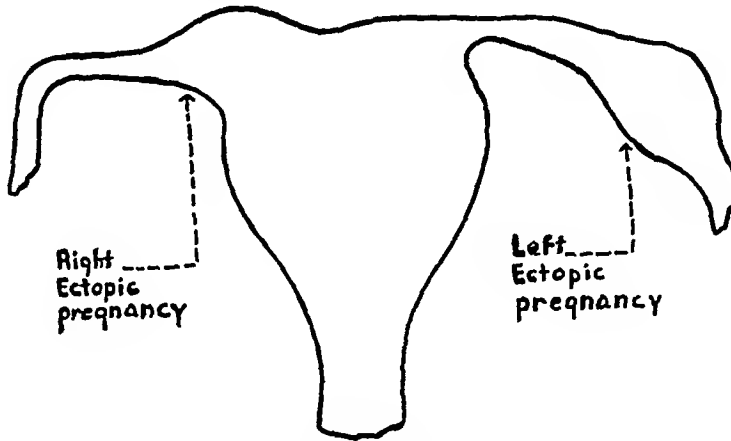


FIG. 1. Showing position of the above described ectopic pregnancies.

was present in the left ovary. The corpus of the uterus was found to contain a mass 2 cm. by $2\frac{1}{2}$ cm. in diameter involving the right cornu and interstitial portion of the right tube. Its surface was multicolored, smooth and glistening, and again there was no evidence of rupture in the wall. Upon opening this tumor a small cavity was exposed and a rough surfaced dark brown mass—old clot—was extruded. The right ovary was found to be essentially normal. A bilateral salpingectomy was performed. The abdomen was closed in layers. The wound expectancy was clean.

Pathological examination by Dr. Rosa Aranoff: "Grossly, the specimen consists of both Fallopian tubes and two irregular pieces of tissue. One tube (right) measures 5 cm. by 0.5 cm. in diameter and reveals a smooth, glistening yellow-pink external surface with an occasional thin-walled distended vessel. The fimbriated extremity is patent. The lumen of the tube is free, the surrounding wall is soft gray-white in color. The other tube (left) is somewhat kinked, measures 5 cm. by 1.5 cm. in diameter. The external surface is smooth, glistening, bluish-gray, covered in places by dry, friable brownish material. The fimbriated extremity is patent. In the cut surfaces of the distal two-thirds the lumen is occupied by soft to firm red-brown jelly-like material merging with the surrounding wall. One of the accompanying portions of tissue measures $2\frac{1}{2}$ cm. by 2 cm., is firm in consistency, and contains an irregular previously emptied cavity about 1 cm. in diameter, the inner surface of which is covered with a

yellow-gray in color. The other portion of tissue measures 2 cm. by $1\frac{1}{2}$ cm. and is made up of material similar to that lining the cavity.

"Microscopically, in a preparation from the right Fallopian tube the lumen is traversed by characteristic slender branching folds, lined by tall cylindrical epithelium. The underlying wall is narrow for the most part with engorged vessels in places. Section from the left Fallopian tube shows a wide lumen filled with clotted blood containing occasional degenerated chorionic villi and scattered groups of preserved Langhans cells. The mucous folds are partly missing and widely separated from one another. The underlying wall is spread apart in places by accumulations of small round cells, large mononuclears, neutrophile polymorphonuclears as well as erythrocytes. Here and there syncytial buds are noted. Parts of the external surface are covered by extravasated blood. In a preparation including the grossly described irregular cavity, the latter reveals a jagged surface bordered in parts by low cylindrical epithelium and containing an occasional similarly lined connective tissue fold. The surrounding and underlying tissue is loose, cellular or more densely fibrous, infiltrated in places with numerous small round cells, large mononuclears many of which are laden with yellow-brown granular material and in some areas with extravasated blood. Embedded in this stroma are scattered hyalinizing chorionic villi; merging with this is a broad layer of fibromuscular tissue with prominent focal perivascular infiltration by chronic inflammatory cells. Section

from the accompanying portion of tissue is made up of clotted blood with a few embedded degenerated chorionic villi."

The diagnosis was, "tubal pregnancy, bilateral, aborted recently on the left and at an earlier date on the right."

The postoperative course was uneventful and the patient was discharged on her twelfth post-operative day.

REMARKS

Lee and Stone³ consider bilateral simultaneous tubal pregnancy still "sufficiently rare to justify reporting any verified case." Torpin⁴ pointed out and others agree that bilateral simultaneous tubal pregnancy must be considered a form of double ovum twin pregnancy. This case again illustrates the necessity of inspecting both adnexa at the time of operation as pointed out by Behney and Hanes.⁵ It also is representative of the point they wish to make in using the title "successive, coexistent tubal pregnancy" for it would definitely appear from gross inspection of these tubal pregnancies that the left side was several weeks younger than the condition that existed in the right tube. Further, in retrospective

consideration of the patient's history one can fit the clinical picture to the gross pathological findings. Apparently the interstitial ectopic pregnancy caused the patient's menstrual upset May 15, 1942, and the ampullary ectopic pregnancy caused her complaints at admission. Microscopically, such a course of reasoning is confirmed. This case again seems to follow the general rule that in cases of bilateral tubal pregnancy there is seldom an indication from the history or physical findings that such a condition existed. This patient was evaluated as an intelligent woman.

We wish to express our appreciation to Dr. Thurston S. Welton, Director, Obstetrics and Gynecology, Greenpoint Hospital, Brooklyn, New York, for granting permission to use this case.

REFERENCES

1. FISHBACK, HAMILTON R. *Am. J. Obst. & Gynec.*, 37: 1035, 1939.
2. COX, M. E. and STEINBERG, M. *Ibid.*, 43: 120, 1942.
3. LEE, G. E. and STONE, EUGENE, T. R. *Ibid.*, 40: 316, 1940.
4. TORPIN, RICHARD. *Ibid.*, 39: 345, 1940.
5. BEHNEY, C. A. and HANES, W. J. *Ibid.*, 40: 316, 1940.



RAT-BITE FEVER*

CASE REPORT

SAMUEL B. BURK, M.D.

Attending Surgeon, Misericordia Hospital

AND

JOSEPH H. HODAS, M.D.

Associate Attending Physician, Misericordia Hospital

NEW YORK, NEW YORK

IN the past few years the term, rat-bite fever, has been divided into two definite and distinct diseases, each with a specific organism as the causative agent. Because of special technics and methods of isolation, more cases have been recently proved and the clinical picture of both has become clearer and better understood.¹

Sodoku, the older, better known, endemic type, is caused by a *Spirochaete*—the *Spirillum minus*. The more recently investigated disease, both endemic and epidemic, known as "Haverhill Fever" is caused by the *Streptobacillus moniliformis*.² Both Sodoku and Haverhill Fever are usually transmitted by rat bite but the latter has also been transmitted by contaminated food and drink.^{3,4} The bite of a dog, cat, mouse, weasel, and skunk have also been reported as sources of entry.⁵

The clinical symptoms in both diseases are different.⁶ Haverhill Fever has a shorter incubation period (from two to ten days), prompt wound healing, severe septic symptoms with arthritis, petechial rash, high fever, marked leucocytosis and no response to antispirechetal therapy. In contrast the spirillum type of infection has a longer incubation period (up to three weeks), a chancre-like initial lesion, lymphadenitis, delayed general symptoms, relapsing fever, slight leucocytosis, and responds well to specific antispirechetal therapy.

The Sodoku type of infection is comparatively rare; only 125 cases having been reported up to January, 1942.⁷ It was found in twenty-eight states and the District of Columbia in the United States. It is especially prevalent in Japan where it was first described by Miyake.⁵

We present another case of Sodoku in

this series with typical history and incubation period, positive clinical and laboratory findings, and favorable response to therapy.

CASE REPORT

Miss A. K., a white female, sixty-five years old, was admitted to the Surgical Service of Misericordia Hospital, New York City, with a history of pain and swelling on the right side of the upper lip of twenty-four hours' duration. She stated that she had been bitten by a rat nine days prior and the wound had been cauterized by her physician on the day after the bite. The wound had healed well with no apparent complications until the day before admission when it became red and swollen. At this time she developed high fever and joint pains, nausea and vomiting.

Examination on admission disclosed two small, apparently healed, purple puncture wounds just above the mucosa on the right side. Surrounding this, there was a red area of induration and swelling about the size of a walnut. The wound was painful to touch but there was no fluctuation. The submaxillary glands on the right side were enlarged and tender.

The patient ran a temperature of between 102 and 104°F. for three days and then the temperature fell by crisis to 100°F. Here it remained for three days more, and at this time the discoloration of the wound became deeper and the puncture wounds ulcerated, although no pus was present. Her temperature rose to 102°F. and subsequently went to 104°F. The patient became semicomatose, refused fluids and food and appeared quite ill. No exanthema was present.

Because of the patient's serious condition, neoarsphenamin⁹ was administered with a marked response. The patient's temperature fell to normal the next day, the induration and discoloration became lessened, and the temperature did not recur. Three doses of neoarsphenamin

* From the Surgical Service of Dr. S. B. Burk, Misericordia Hospital, New York City.

min were administered intravenously at five-day intervals, the initial dose being .15 mg. The induration disappeared but the puncture wounds were still open and draining. The patient, except for slight scarring of the lip recovered uneventfully.

Laboratory findings were as follows: Urine: a trace of albumin; leucocytes—5 to 10 per high power field, red cells 1 or 2. On May 29, 1938, hemoglobin was 110 per cent; red blood cells 5,900,000; white blood cells, 12,150; polymorphonuclears—60 per cent; lymphocytes 40 per cent. On June 3rd, white blood cells were 13,300; polymorphonuclears 85 per cent; lymphocytes 15 per cent. Wassermann report on June 3rd was negative. Blood culture was sterile. The culture from wound was negative at first but later showed hemolytic staphylococci (probably a secondary invader). A smear taken directly from the ulcerated wound (dark field examination) was reported by the Department of Health as positive for *Spirillum*.

REMARKS

We notice an incubation period of about a week with complete healing of the wound and no systemic symptoms. In the series of cases reviewed, the incubation period was usually from one to sixty days and averaged about two weeks. The febrile attacks usually last two or three days and one or more are characteristic. The rash usually does not appear until the fourth paroxysm of fever. In our case it probably did not appear because of the early administration of nearsphenamin. The interval usually varies from two to fourteen days with amelioration of the local symptoms. With the onset of the febrile attack, pain and swelling are marked around the local lesion which resembles a chancre or the initial lesion of tuleremia. In typical cases, glandular involvement and lymphadenitis are usually present. The exanthema, about which much has been written, consists usually of red or bluish red macules, 3 to 10 cm. in size, and at times even resemble the rash of measles.

DIAGNOSIS

The diagnosis can usually be made by the following factors: (1) History of bite or

scratch (there must be a break in the continuity of the skin); (2) symptomless incubation period of about one day to six weeks; (3) local signs and symptoms with a breaking down and ulceration of the lesion just preceding and during the febrile attack; (4) afebrile period of from two to seven days with apparent healing of initial lesion; (5) repeated bouts of fever; (6) therapeutic response to nearsphenamin which usually requires from one to twelve intravenous injections. (7) The Wassermann and Kahn tests were negative in this case, both during and subsequent to the actual infection, possibly because of early and adequate therapy. Other investigators have recently found some changes in these reactions.⁸ (8) The diagnosis is usually proved by the injection of the patient's blood into a guinea pig or mouse which has previously been examined and found negative for the *Spirillum*. The optimum time for examination of the infected animal seems about twenty days after injection.¹⁰ Direct dark field examination and puncture of glands is also used but with less apparent success than with the above method. Examination of smears should be made about one hour after the blood is placed on the smear.

This comparatively rare disease usually has a mortality of about 10 per cent. However, with early clinical recognition, adequate laboratory work-up, and sufficient specific therapy, this mortality can be markedly reduced if not completely eliminated.

REFERENCES

1. HART, A. D. JR. *Virginia Med. Month.*, 68: 582-584, 1941.
2. WOOLEY, PAUL V. JR. *J. Pediat.*, 19: 515-525, 1941.
3. PARKER and HUDSON. *Am. J. Pathol.*, 2: 357, 1926.
4. PLACE and SUTTON. *Arch. Int. Med.*, 54: 659, 1934.
5. BAYNE-JONES, S. *Internat. Clin.*, 3: 235, 1931.
6. FERREL, E. et al. *Arch. Int. Med.*, 64: 1, 1939.
7. BROWN, THOMAS MCP. and NUNEMAKER, JOHN C. *Bull. Johns Hopkins Hosp.*, 70: 201-334, 1942.
8. ALLBRITTEN, F. F. et al. *J. A. M. A.*, 114: 2360, 1940.
9. O'LEARY, P. A. *Arch. Dermat. & Syph.*, 9: 293, 1924.
10. GARVIN, J. A. *Ohio State M. J.*, 33: 1235, 1937.

AUTHOR INDEX TO VOLUME LX

- Adams, E. Lawrence, 105
 Al Akl, F. M., 248
 Albee, Fred H., 349
 Allen, Frederick M., 335
 Auerbach, S. F., 235

 Bachhuber, Carl A., 96
 Basom, W. Compere, 151
 Berson, Morton I., 101
 Berwald, William P. E., 447
 Bettman, Ralph Boerne, 243
 Bird, W. Edwin, 81
 Birnkrant, Milton, 182
 Bolen, H. Leonard, 289
 Breck, Louis W., 151
 Bruckner, John P., 292
 Buch, Irwin M., 396
 Burk, Samuel B., 453
 Buxton, R. W., 252

 Capps, Richard B., 433
 Carlucci, Gaston A., 209
 Case, James T., 159
 Castleton, Kenneth B., 190
 Chapman, Jean L., 286
 Cohen, Ira, 36
 Cole, Lewis Gregory, 3
 Conway, John F., 386
 Cottis, G. W., 204

 Dealy, Frank N., 63
 Demakopoulos, Nicholas, 76
 Denker, Peter G., 13
 Di Lorenzo, Costabile, 319
 Dobelle, Martin, 130
 Dorman, Daniel B., 403
 Drysdale, H. Raymond, 122

 Echols, Dean H., 134
 Eger, S. A., 140

 Foster, George C., 2

 Gladden, James R., 277
 Gold, I. Roy, 144
 Goldberg, Samuel L., 255
 Goodman, Charles, 196

 Grace, Edwin J., 361
 Gratch, I., 411
 Grayzel, David M., 144

 Haines, Charles, 119
 Hayden, Reynolds, 161
 Hellendall, Hugo, 22
 Herrlin, John, Jr., 126
 Hodas, Joseph H., 453
 Hooker, Donald H., 88
 Howes, William E., 182
 Howley, Clarence, 319

 Janota, Martha, 371
 Jensen, D. Rees, 301
 Jensen, R. M., 429
 Johnston, W. M., 313
 Joldersma, R. D., 50
 Joseph, Edward G., 381

 Kaplan, Abraham, 36
 Kennedy, Foster, 13
 Kernwein, Graham A., 433
 Kleinsasser, L. R. J., 134
 Kurzrok, Lawrence, 450

 Large, Octavus P., 415
 Laufman, Harold, 243
 Lawrence, Joseph, 264
 Lev, Maurice, 115
 Lewin, Philip, 371
 Love, Carruthers, 264
 Lubin, Samuel, 298

 Macdonald, Dean, 122
 Martland, Harrison S., 424
 Masland, H. C., 154
 Massell, Theodore B., 142
 McCrea, Lowrain E., 328
 McLaughlin, Edward F., 311
 Mersheimer, Walter L., 126
 Mietus, A. C., 399
 Miley, George, 354
 Mitchell, R. M., 399, 450
 Mossman, H. W., 286

 Norment, W. B., 56

 Olsman, Louis, 115
 Osborne, Raymond, 13

 Phillips, John Roberts, 137
 Posner, A. Charles, 396
 Pugh, H. L., 429

 Rankin, L. M., 140
 Ritter, Henry H., 112
 Robillard, G. L., 235
 Ross, Charles A., 386
 Rothman, Milton, 292, 319, 443
 Rumold, Mervin J., 149

 Sachs, Allan E., 255
 Scheman, Louis, 371
 Shapiro, A. L., 235
 Sideman, Sidney, 371
 Simon, Max Michael, 212
 Sloane, David, 272
 Smith, Roland T., 438
 Stevens, N. C., 365

 Tepper, Gilbert B., 142
 Thatcher, Herbert H., 44
 Thompson, Malcom, 1
 Toman, Andrew J., 270
 Totten, H. P., 227

 Waltman, Richard, 298
 Waugh, Richey L., 309
 Waugh, W. Grant, 231
 Weaver, James B., 149
 Weeks, Richard B., 260
 Weinschel, Leo R., 76
 Weinstein, M. L., 105, 267
 Welch, Esther M., 309
 White, M. L., Jr., 252
 Whittington, Claude T., 304
 Wilensky, Abraham O., 221
 Williams, Henry Ward, 447

 Young, George G., 260

 Zetena, Dominick F., 292, 443

SUBJECT INDEX TO VOLUME LX

(Bo. B.) = Bookshelf Browsing; (E.) = Editorial

A

- Abdomen
 - auscultation of, in appendicitis, 365
 - injuries to, 319
 - surgery of (E.), 1
- Abscess, myocardial, and perforation of heart, 277
- Actinomycosis of liver and lungs, 438
- Adenitis, cervical, tuberculous, 231
- Ampulla, carcinoma of, 137
- Amputation of buttock, 149
- Anastomosis
 - gastrojejunal, and Rankin clamp, 227
 - of pancreatic duct and jejunum, 137
- Anesthesia
 - avertin, in gynecology, 403
 - caudal, in obstetrics, 399
 - continuous, caudal, 396
 - deaths caused by, 63
- Anorectum, pain of, due to ovarian cyst, 289
- Anuria, sulfathiazole, 105
- Appendicitis, auscultation of abdomen in, 365
- Argentaffinomas in ileum, 144
- Army, localization and extraction of foreign body by, 3
- Artery, thyroid, inferior, 96
- Asphyxia during gunshot surgery, 270
- Auricle, reconstruction of, 101
- Auscultation of abdomen in appendicitis, 365
- Avertin in gynecology, 403

B

- Bacillus proteus OX19, 411
- Blast, water, and injury, 429
- Blood
 - irradiation of, 354
 - vessel suture, 196
- Body, foreign, localization and extraction of, 3
- Bone plating, fallacies of, 50
- Book Reviews:
 - Blood Substitutes and Blood Transfusion, 306
 - Clinical Anesthesia—A Manual of Clinical Anesthesiology, 307
 - First Aid—Surgical and Medical, 307
 - Fractures, 308
 - Hemorrhagic Diseases and the Physiology of Hemostasis, 306
 - Human Embryology, 307
 - Medical Parasitology, 308
 - Miracles of Military Medicine, 307
 - Obstetrical Practice, 156
 - Oxford Medical Outline Series, 308
 - Principles and Practice of Medicine, 156
 - Psychotherapy in Medical Practice, 307
 - Religion and Health, 306
 - Sulfanilamide and Related Compounds in General Practice, 307
- Boric acid, dangers of, 381
- Brain injuries (E.), 159
- Breast, tumors of, 235
- Breasts, supernumerary, 76
- Brooklyn Cancer Institute, melanoma at, 182
- Brucella spondylitis, 130
- Burn therapy (E.), 311
- Buttock, amputation of, 149

C

- Canal, uterine, study of, 56
- Cancer
 - of breast, 235
 - of lung and smoking, 361

Carcinoma

- and torsion of cord, 304
- multiple, 22
- of ampulla, 137
- Casualties, battle, 161
- Cauda equina, tumors of, 36
- Caudal anesthesia, continuous, 396, 399
- Cecum
 - rupture of, 142
 - volvulus of, 292
- Children, ovarian cysts in, 140
- Chordoma, sacrococcygeal, 115
- Clamp, Rankin, and anastomosis, 227
- Clavicles, fractured, shoulder lift for, 154
- Colon
 - ascending, volvulus of, 292
 - neoplasm of, 126
 - splenic, obstruction of, 142
- Color in operating room (E.), 309
- Complications of thyroid surgery, 96
- Control of thrombophlebitis, 354
- Cord, torsion of, and undescended testicle, 304
- Cyst, solitary, of kidney, 328
- Cysts
 - of sacrococcyx, 260
 - ovarian, and anorectal pain, 289
 - in children, 140
 - pilonidal, 264

D

- Dangers of boric acid, 386
- Deaths, anesthetic, 63
- Decapsulation of kidneys, 105
- Deformity, Madelung's, 272
- Dembrol hydrochloride, 267
- Dilatation of stomach, 381
- Diverticulum
 - Meckel's, 443
 - of sigmoid, 119
- Drainage, peritoneal, 204
- Drill, saw and Kirschner wire drill guide, 151
- Duct
 - bile, exploration of, 88
 - common, reconstruction of, 209
- Duodenum
 - excision of, 137
 - pancreatic nodule in, 286

E

- Eradication of hemangioma, 149
- Event, historical, and a great physician (E.), 160
- Excision of duodenum and head of pancreas, 137
- Exploration of common bile duct, 88
- Extraction of foreign body, 3

F

- Fallacies of bone plating, 50
- Fallacy of peritoneal drainage, 204
- Femur, intertrochanteric fractures of, 44
- Fever
 - rat-bite, 453
 - scarlet, and thyroiditis, 301
 - undulant, and spondylitis, 130
- Fixation, internal, of fractures of femur, 44
- Foreskin isografts, 255
- Fractures
 - clavicular, shoulder lift for, 154
 - intertrochanteric of femur, 44
 - of skull (E.), 159

Glioblastoma multiforme, 447

Guide, electric drill, 151

Gynecology, avertin in, 403

Healing in thoracoplasty wounds, 252

Heart, perforation of, 277

Hemangioma

cavernous, of skull, 134

of buttock, 149

Hemo-irradiation, thrombophlebitis and, 354

Hernia, Littre's, 81

Ileum, argentaffinomas in, 144

Injuries

brain (E.), 159

intestinal, caused by forceps, 424

intra-abdominal, 319

Injury, water blast, 429

Intestine

obstruction to, 443

trauma to, during laparotomy, 424

Irrigant, boric acid as, 386

Isografts, foreskin, 255

Jaundice, medical, surgery for, 122

Kidney, solitary cyst of, 328

Kidneys, decapsulation of, 105

Knee, repair of ligaments of, 349

Laparotomy, intestinal, trauma during, 424

Larynx, nerve of, in thyroid surgery, 212

Ligaments of knee, repair of, 349

Ligation, saphenous, 248

Littre's umbilical hernia, 81

Liver

actinomycosis of, 438

metastasis to, 144

Lloyd-Davies technic in rectal resection, 243

Lobelin in asphyxia, 270

Localization of foreign body, 3

Lung

actinomycosis of, 438

cancer of, and smoking, 361

Madelung's deformity in sisters, 272

Management of tumors of breast, 235

Meckel's diverticulum and intestinal obstruction, 443

Melanoma, 182

Metastases in lymph nodes and liver, 144

Naval Hospital activities at Pearl Harbor, 161

Navy, surgical operations in, 313

Neoplasm, multiple, of colon, 126

Nerve

laryngeal, in thyroid surgery, 212

recurrent, 96

Nodes, lymph, metastasis to, 144

Nodule, pancreatic, in duodenum, 286

Obstetrics, caudal anesthesia in, 399

Obstruction

intestinal, and Meckel's diverticulum, 443

malignant, of splenic colon, 142

Operation, new, for repair of ligaments of knee, 349

Operations, surgical, in navy, 313

Osteomyelitis

experimental, 371

typhoid, 433

Ovary

cysts of, and anorectal pain, 289

in children, 140

Pain, anorectal, due to ovarian cyst, 289

Pancreas

annular, 286

head of, excision of, 137

Pearl Harbor Naval Hospital, 161

Perforation

of diverticulum of sigmoid, 119

of heart and staphylococcal pyemia, 277

Physician, a great (E.), 160

Plating of bone, 50

Polymastia, 76

Pregnancies, tubal, coexistent, 450

Pregnancy, abdominal, 298

Pseudomamma type of breasts, 76

Pyemia, staphylococcal, and perforation of heart, 277

Rankin clamp and anastomosis, 227

Rat-bite fever, 453

Reactions, tissue, from sutures, 415

Reconstruction

of auricle, 101

of common duct with vitallium tube, 209

Rectum, radical resection of, 243

Repair of ligaments of knee, 349

Resection, radical, of rectum, 243

Room, operating, color in (E.), 309

Rupture of cecum, 142

Sacrococcygeal cysts, 260

Sacrococcygeus, chordoma of, 115

Salt Lake City Hospitals, biliary surgery at, 190

Scarlet fever and thyroiditis, 301

Serum of pregnant women and bacillus proteus OX19, 411

Shock

therapy of, 335

treatment of, 112

Shoulder lift for fractured clavicles, 154

Sigmoid, diverticulum of, 119

Sisters, Madelung's deformity in, 272

Skull

fractures (E.), 159

hemangioma of, 134

Smoking and cancer of lung, 361

South Pacific, surgical operations in, 313

Spine, tumors of, 36

Spondylitis and undulant fever, 130

Sponge and tissue forceps injuries, 424

Stomach, dilatation of, 381

Study of uterine canal, 56

Suggestion (E.), 160

Sulfanilamide in perforation of sigmoidal diverticulum, 119

Sulfathiazole anuria, 105

Sulfonamides, use of, postoperatively (E.), 2

Surgery

abdominal (E.), 1

biliary, 88

tract, 190

for medical jaundice, 122

gunshot, asphyxia during, 270

thyroid, complications of, 96

laryngeal nerve in, 212

Suture of blood vessel, 196

Sutures

and healing in thoracoplasty wounds, 252
new, and tissue reactions, 415

Technic of saphenous ligation, 248

Temperature, reduced, in shock, 335

Testicle, intra-abdominal, torsion of cord and carcinoma, 304

Therapy of shock, 335

Thyroiditis and scarlet fever, 301

Thyroid surgery, laryngeal nerve in, 212

Thrombophlebitis, control of, 354

Thyrototoxicosis and war effort, 221

Tissue reactions from new sutures, 415

Tract, biliary, surgery of, 190

Trauma, intestinal, caused by instruments, 424

Treatment

for dilatation of stomach, 381

of shock, 335

and fresh wounds, 112

surgical, of medical jaundice, 122

Tube, vitallium, in common duct, 209

Tubes, successive pregnancies in, 450

Tumors

of breast, 235

Tumors of cauda equina, 36

Typhoid osteomyelitis, 433

Ultraviolet blood irradiation, 354

Uterogram for study of uterus, 56

Uterus, study of, by observation on uterogram, 56

Vein

saphenous, ligation of, 248

thyroid, middle, 96

Vessel, blood, suture of, 196

Vitallium tube in common duct, 209

Volvulus, 443

of cecum and ascending colon, 292

War effort and thyrototoxicosis, 221

Water blast injury, 429

Wounds

fresh, treatment of, 112

thoracoplasty, healing of, 252

X-ray examinations in skull fractures and brain injuries (E.), 159

